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THE DEVELOPMENT OF POLITICAL INSTITUTIONS.

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IX.—REPRESENTATIVE BODIES.

AMID the varieties and complexities of political organization, it has proved not impossible to discern the ways in which simple political heads and compound political heads are evolved; and how, under certain conditions, the two become united as ruler and consultative body. But, to see how a representative body arises, proves to be more difficult; for both process and product are more variable. Less specific results must content us.

As hitherto, so again, we must go back to the beginning to take up the clew. Out of that earliest stage of the savage horde in which there is no supremacy beyond that of the man whose strength, or courage, or cunning, gives him predominance, the first step is to the practice of election—deliberate choice of a leader in war. About the conducting of elections in rude tribes travelers are silent: probably the methods used are various. But we have accounts of elections as they were made by European peoples during early times. In ancient Scandinavia, the chief of a province, chosen by the assembled people, was thereupon "elevated amid the clash of arms and the shouts of the multitude"; and among the ancient Germans he was carried on a shield. Recalling, as this ceremony does, the chairing of a newly elected member of Parliament up to recent times, and reminding us that originally among ourselves election was by show of hands, we are taught that the choice of a representative was once identical with the choice of a chief. Our House of Commons had its roots in local gatherings like those in which uncivilized tribes select head warriors.

Besides conscious selection, there occurs among rude peoples selec-

tion by lot. The Samoans, for instance, by spinning a cocoanut, which on coming to rest points to one of the surrounding persons, thereby single him out. Early historic races supply illustrations; as the Hebrews in the affair of Saul and Jonathan, and as the Homeric Greeks when fixing on a champion to fight with Hector. In both these last cases there was belief in supernatural interference: the lot was supposed to be divinely determined. And probably at the outset, choice by lot for political purposes among the Athenians, and for military purposes among the Romans, as, also, in later times, the use of the lot for choosing deputies in some of the Italian republics, and in Spain (as in Leon during the twelfth century), was influenced by a kindred belief; though doubtless the desire to give equal chances to rich and poor, or else to assign without dispute a mission which was onerous or dangerous, entered into the motive or was even predominant. Here, however, the fact to be noted is, that this mode of choice which plays a part in representation may also be traced back to the usages of primitive peoples.

So, too, we find foreshadowed the process of delegation. Groups of men who open negotiations, or who make their submission, or who send tribute, habitually appoint certain of their number to act on their behalf. The method is, indeed, in such cases necessitated; since a tribe can not well perform such actions bodily. Whence, too, it appears that the appointing of representatives is, at the first stage, originated by causes like those which reoriginate it at a later stage. For, as the will of the tribe, readily displayed in its assemblies to its own members, can not be thus displayed to other tribes, but must, in respect of inter-tribal matters, be communicated by deputy, so, in a large nation, the people of each locality, able to govern themselves locally, but unable to join the peoples of remote localities in deliberations which concern them all, have to send one or more persons to express their will. Distance in both cases changes direct utterance of the popular voice into indirect utterance.

Before observing the conditions under which this singling out of individuals in one or other way for appointed duties comes to be used in the formation of a representative body, we must exclude classes of cases not relevant to our present inquiry. Though representation as ordinarily conceived, and as here to be dealt with, is associated with a popular form of government, yet the connection between them is not a necessary one. In some places and times representation has coexisted with entire exclusion of the masses from power. In Poland, both before and after the so-called republican form was assumed, the central Diet, in addition to senators nominated by the king, was composed of nobles elected in provincial assemblies of nobles: the people at large being powerless and mostly serfs. In Hungary, too, up to recent times, the privileged class, which, even after it had been greatly enlarged, reached only "one twentieth of the adult males," alone

formed the basis of representation. "A Hungarian county before the reforms of 1848 might be called a *direct* aristocratical republic," all members of the noble class having a right to join the local assembly and vote in appointing a representative noble to the general Diet, but the inferior classes having no share in the government.

Other representative bodies than those of an exclusively aristocratic kind must be named as not falling within the scope of this chapter. As Duruy remarks: "Antiquity was not as ignorant as is supposed of the representative system. . . . Each Roman province had its general assemblies. . . . Thus the Lycians possessed a true legislative body formed by the deputies of their twenty-three towns. . . . This assembly had even executive functions." And Pavia, Gaul, Spain, all the eastern provinces, and Greece, had like assemblies. But, little as is known of them, the inference is tolerably safe that these were but distantly allied in genesis and position to the bodies we now distinguish as representative. Nor are we concerned with governing senates and councils elected by different divisions of a town-population, such as those which were variously formed in the Italian republics—bodies which served simply as agents whose doings were subject to the directly-expressed approval or disapproval of the assembled citizens. Here we must limit ourselves to that kind of representation which arises in communities occupying areas so large that their members are obliged to exercise by deputies such powers as they possess; and, further, we have to deal exclusively with cases in which the assembled deputies do not replace preëxisting political agencies, but coöperate with them.

It will be well to set out by observing, more distinctly than we have hitherto done, what part of the primitive political structure it is from which the representative body, as thus conceived, originates.

Broadly, this question is tacitly answered by the contents of the preceding chapters. For, if, on occasions of public deliberation, the primitive horde spontaneously divides into the inferior many and the superior few, among whom some one is most influential; and if, in the course of the compounding and recompounding of groups which war brings about, the recognized war-chief develops into the king, while the superior few become the consultative body formed of minor military leaders—it follows that any third coördinate political power must be either the mass of the inferior itself, or else some agency acting on its behalf. Truism though this may be called, it is needful here to set it down; since, before inquiring under what circumstances the growth of a representative system follows the growth of popular power, we have to recognize the relation between the two.

The undistinguished mass, retaining a latent supremacy in simple societies not yet politically organized, though it is brought under restraint as fast as war establishes submission, and conquests produce

class-differentiations, tends, when occasion permits, to reassert itself. The sentiments and beliefs, organized and transmitted, which, during certain stages of social evolution, lead the many to submit to the few, come, under some circumstances, to be traversed by other sentiments and beliefs. Passing references have been in several places made to these. Here we must consider them *seriatim* and more at length.

One factor in the development of the patriarchal group during the pastoral stage was shown to be the fostering of subordination to its head by war; since, continually, there survived the groups in which subordination was greatest. But, if so, the implication is that, conversely, cessation of war tends to diminish subordination. Members of the compound family, originally living together and fighting together, become less strongly bound in proportion as they have less frequently to coöperate for joint defense under their head. Hence, the more peaceful the state the more independent become the multiplying divisions forming the gens, the phratry, and the tribe. With progress of industrial life arises greater freedom of action—especially among the distantly-related members of the group.

So must it be, too, in a feudally-governed assemblage. While standing quarrels with neighbors are ever leading to local battles; while bodies of men-at-arms are kept ready, and vassals are from time to time summoned to fight; while, as a concomitant of military service, acts of homage are insisted upon—there is maintained a regimental subjection running through the group. But, as fast as aggressions and counter-aggressions become less frequent, the carrying of arms becomes less needful; there is less occasion for the periodic expressions of fealty; and there is a proportionate increase of daily actions carried on without direction of a superior, fostering increased individuality of character.

These changes are furthered by the decline of superstitious beliefs concerning the natures of head-men, general and local. As before shown, the ascription of superhuman origin, or supernatural power, to the king, greatly strengthens his hands; and where the chiefs of component groups have a sacredness due to nearness in blood to the semi-divine ancestor worshiped by all, or are members of an invading, god-descended race, their authority over dependents is largely enforced. By implication, then, anything which undermines ancestor-worship, and the system of beliefs accompanying it, favors the growth of popular power. Doubtless the spread of Christianity over Europe, by diminishing the prestige of governors, major and minor, prepared the way for greater independence of the governed.

These causes have relatively small effects where the people are scattered. In rural districts the authority of political superiors is weakened with comparative slowness. Even after peace has become habitual, and local heads have lost their semi-sacred characters, there cling to them awe-inspiring traditions; they are not of ordinary flesh

and blood. Wealth, which, through long ages, distinguishes the nobleman exclusively, gives him both actual power and the power arising from display. Fixed literally or practically, as the several grades of his inferiors are during days when locomotion is difficult, he long remains for them the solitary sample of a great man: others are known only by hearsay; he is known by experience. Inspection is easily maintained by him over dependent and sub-dependent people; and the disrespectful or rebellious, if they can not be punished overtly, can be deprived of occupation, or otherwise so hindered in their lives that they must submit or migrate. Down to our own day, the behavior of peasants and farmers to the squire is suggestive of the strong restraints which kept rural populations in semi-servile states after primitive controlling influences had died away.

Converse effects may be expected under converse conditions, namely, where large numbers become closely aggregated. Even if such large numbers are formed of groups severally subordinate to heads of clans, or to feudal superiors, sundry influences combine to diminish subordination. When there are present in the same place many superiors to whom respectively their dependents owe obedience, these superiors tend to dwarf one another. The power of no one is so imposing if there are daily seen others who make like displays. Further, when groups of dependents are mingled, supervision can not be so well maintained by their heads. And this, which hinders the exercise of control, facilitates combination among those to be controlled; conspiracy is made easier and detection of it more difficult. Again, jealous of one another, as these heads of clustered groups are likely in such circumstances to be, they are prompted severally to strengthen themselves, and to this end, competing for popularity, are tempted to relax the restraints over their inferiors and to give protection to inferiors ill-used by other heads. Still more are their powers undermined when the assemblage comes to include many aliens. As before implied, this, above all causes, favors the growth of popular power. In proportion as immigrants, detached from the gentile or feudal divisions they severally belong to, become numerous, they weaken the structures of the divisions among which they live. Such organization as these strangers fall into is certain to be a looser one; and their influence becomes a dissolving agency to the surrounding organizations.

And here we are brought back to the truth which can not be too much insisted upon, that growth of popular power is in all ways associated with trading activities. For only by trading activities can many people be brought to live in close contact. Physical necessities maintain the wide dispersion of a rural population; while physical necessities impel the gathering together of those who are commercially occupied. Evidence from various countries and times shows that periodic gatherings for religious rites, or other public purposes, furnish opportunities for buying and selling, which are habitually utilized;

and this connection between the assembling of many people and the exchanging of commodities, which first shows itself at intervals, becomes a permanent connection where many people become permanently assembled—where a town grows up in the neighborhood of a temple, or around a stronghold, or in a place where local circumstances favor some manufacture.

Industrial development further aids popular emancipation by generating an order of men whose power, derived from their wealth, competes with, and begins in some cases to exceed, the power of those who previously were alone wealthy—the men of rank. While this initiates a conflict which diminishes the influence previously exercised by patriarchal or feudal heads only, it also initiates a milder form of subordination. Rising, as the rich trader habitually does in early times, from the non-privileged class, the relation between him and those under him is one from which there is excluded the idea of personal subjection. In proportion as the industrial activities become predominant, they make familiar a connection between employer and employed, which differs from the relation between master and slave, or lord and vassal, by not including allegiance. Under earlier conditions there does not exist the idea of detached individual life—life which neither receives protection from a clan-head or feudal superior nor is carried on in obedience to him. But in town-populations, made up largely of refugees, who either become small traders or are employed by large ones, the experience of a relatively independent life becomes common, and the conception of it distinct.

And the form of coöperation distinctive of the industrial state which thus arises fosters the feelings and thoughts appropriate to popular power. In daily usage there is a balancing of claims; and the conception of equity is, generation after generation, made clearer. The relations between employer and employed, and between buyer and seller, can be maintained only on condition that the obligations on either side are fulfilled. Where they are not fulfilled the relation lapses, and leaves outstanding those relations in which they are fulfilled. Commercial success and growth have thus, as their inevitable concomitants, the maintenance of the respective claims of those concerned, and a strengthening consciousness of them.

In brief, then, dissolving in various ways the old relation of *status*, and substituting the new relation of contract (to use Sir Henry Maine's antithesis), progressing industrialism brings together masses of people who by their circumstances are enabled, and by their discipline prompted, to modify the political organization which militancy has bequeathed.

It is common to speak of free forms of government as having been initiated by happy accidents. Antagonisms between different powers in the state, or different factions, have caused one or other to bid for

popular support, with the result of increasing popular power. The king's jealousy of the aristocracy has induced him to enlist the sympathies of the people—sometimes serfs, but more frequently citizens—and therefore to favor them; or, otherwise, the people have profited by alliance with the aristocracy in resisting royal tyrannies and exactions. Doubtless, the facts admit of being thus presented. With conflict there habitually goes the desire for allies; and throughout mediæval Europe, while the struggles between monarchs and barons were chronic, the support of the towns was important. Germany, France, Spain, Hungary, furnish illustrations.

But it is an error to regard occurrences of these kinds as causes of popular power. They are to be regarded rather as the conditions under which the causes take effect. These incidental weakenings of pre-existing institutions do but furnish opportunities for the action of the pent-up force which is ready to work political changes. Three factors in this force may be distinguished—the relative mass of those composing the industrial communities as distinguished from those embodied in the older forms of organization; the permanent sentiments and ideas produced in them by their mode of life; and the temporary emotions excited by special acts of oppression or by distress. Let us observe the coöperation of these.

Two instances, occurring first in order of time, are furnished by the Athenian democracy. The condition which preceded the Solonian legislation was one of violent dissension among political factions; and there was also "a general mutiny of the poorer population against the rich, resulting from misery combined with oppression." The more extensive diffusion of power, effected by the revolution which Kleisthenes brought about, occurred under kindred circumstances. The relatively-detached population of immigrant traders had so greatly increased between the time of Solon and that of Kleisthenes that the four original tribes forming the population of Attica had to be replaced by ten. And then this augmented mass, largely composed of men not under clan-discipline, and therefore less easily restrained by the ruling classes, forced itself into predominance at a time when the ruling classes were divided. Though it is said that Kleisthenes, "being vanquished in a party contest with his rival, took the people into partnership"—though the change is represented as being one thus personally initiated—yet, in the absence of that voluminous popular will which had long been growing, the political reorganization could not have been made, or, if made, could not have been maintained. The remark which Grote quotes from Aristotle, that "seditions are generated by great causes, but out of small incidents," if altered slightly by writing "political changes" instead of "seditions," fully applies. For clearly, once having been enabled to assert itself, this popular power could not be forthwith excluded. Kleisthenes could not under such circumstances have imposed on so large a mass of men arrangements at vari-

ance with their wishes. Practically, therefore, it was the growing industrial power which then produced, and thereafter preserved, the democratic organization. Turning to Italy, we first note that the establishment of the small republics, referred to in a preceding chapter as having been simultaneous with the decay of imperial power, may here be again referred to more specifically as having been simultaneous with that conflict of authorities which caused this decay. Says Sismondi, "The war of investitures gave wing to this universal spirit of liberty and patriotism in all the municipalities of Lombardy, of Piedmont, Venetia, Romagna, and Tuscany." In other words, while the struggle between emperor and pope absorbed the strength of both, it became possible for the people to assert themselves. And at a later time Florence furnished an instance similar in nature if somewhat different in form.

> At the moment when "Florence expelled the Medici, that republic was bandied between three different parties." Savonarola took advantage of this state of affairs to urge that the people should reserve their power to themselves, and exercise it by a council. His proposition was agreed to, and this "council was declared sovereign, on the 1st of July, 1495."

In the case of Spain, again, popular power increased during the troubles accompanying the minority of Fernando IV; and of the periodic assemblies subsequently formed by deputies from certain towns (which met without authority of the government) we read that—

> The desire of the Government to frustrate the aspiring schemes of the Infantes de la Cerda, and their numerous adherents, made the attachment of these assemblies indispensable. The disputes during the minority of Alfonso XI more than ever favored the pretensions of the third estate. Each of the candidates for the regency paid assiduous court to the municipal authorities, in the hope of obtaining the necessary suffrages.

And how all this was consequent on industrial development appears in the facts that many, if not most, of these associated towns had arisen during a preceding age by the recolonization of regions desolated during the prolonged contests of Moors and Christians; and that these *poblaciones*, or communities of colonists, which, scattered over these vast tracts, grew into prosperous towns, had been formed of serfs and artisans to whom various privileges, including those of self-government, were given by royal charter. With which several examples must be joined the example familiar to all. For it was during the struggle between king and barons, when the factions were nearly balanced, and when the town-populations had been by trade so far increased that their aid was important, that they came to play a noticeable part, first as allies in war and afterward as sharers in government. It can not be doubted that, when summoning to the Parliament of 1265 not only knights of the shire but also deputies from cities and boroughs, Simon de Montfort was prompted by the desire to strengthen

himself against the royal party supported by the Pope. And whether he sought thus to increase his adherents or to obtain larger pecuniary means, or both, the implication equally is that the urban populations had become a relatively important part of the nation. This interpretation harmonizes with subsequent events. For, though the representation of towns afterward lapsed, yet it shortly revived, and in 1295 became established. As Hume remarks, such an institution could not "have attained to so vigorous a growth and have flourished in the midst of such tempests and convulsions," unless it had been one "for which the general state of things had already prepared the nation"; the truth here to be added being that this "general state of things" was the augmented mass, and consequently augmented influence, of the free industrial communities.

Confirmation is supplied by cases showing that power, gained by the people during times when the regal and aristocratic powers are diminished by dissension, is lost again if, while the old organization recovers its stability and activity, industrial growth does not make proportionate progress. Spain, or more strictly Castile, yields an example. Such share in government as was acquired by those industrial communities which grew up during the colonization of the waste lands became, in the space of a few reigns, characterized by wars and consolidations, scarcely more than nominal.

It is instructive to note how that primary incentive to coöperation which initiates social union at large continues afterward to initiate special unions within the general union. For, just as external militancy sets up and carries on the organization of the whole, so does internal militancy set up and carry on the organization of the parts, even when those parts, industrial in their activities, are intrinsically non-militant. On looking into their histories we find that the increasing clusters of people who, forming towns, lead lives essentially distinguished by continuous exchange of services under agreement, develop their governmental structures during their chronic antagonisms with the surrounding militant clusters.

We see, first, that these settlements of traders, growing important and obtaining royal charters, were by doing this placed in quasi-militant positions—became in modified ways holders of fiefs from their king, and had the associated responsibilities. Habitually they paid dues of sundry kinds equivalent in general nature to those paid by feudal tenants; and, like them, they were liable to military service. In Spanish chartered towns "this was absolutely due from every inhabitant"; and "every man of a certain property was bound to serve on horseback or pay a fixed sum." In France "in the charters of incorporation which towns received, the number of troops required was usually expressed." And in the chartered royal burghs of Scotland "every burgess was a direct vassal of the crown."

Next observe that industrial towns, usually formed by coalescence of preëxisting rural divisions rendered populous because local circumstances favored some form of trade, and presently becoming places of hiding for fugitives, and of security for escaped serfs, began to stand toward the small feudally-governed groups around them in relations like those in which these stood to one another: competing with them for adherents, and often fortifying themselves.

Again, there is the fact that these cities and boroughs, which by royal charter or otherwise had acquired powers of administering their own affairs, habitually formed within themselves combinations for protective purposes. In England, in Spain, in France, in Germany—sometimes with assent of the king, sometimes notwithstanding his reluctance as in England, sometimes in defiance of him, as in ancient Holland—there rose up guilds, which, having their roots in quasi-religious unions among related persons, presently gave origin to frith-guilds and merchant-guilds; and these, defensive in their relations to one another, formed the basis of that municipal organization which carried on the general defense against aggressing nobles.

Then there is the further fact that, in countries where the antagonisms between these industrial communities and the surrounding militant communities were violent and chronic, the industrial communities combined to defend themselves. In Spain, the *poblaciones*, which when they flourished and grew into large towns were invaded and robbed by adjacent feudal lords, formed leagues for mutual protection; and again, at a later date, there arose under like needs, more extensive confederations of cities and towns, which, under severe penalties for non-fulfillment of the obligations, bound themselves to aid one another in resisting aggressions, whether by king or nobles. In Germany, too, we have the perpetual alliance entered into by sixty towns on the Rhine in 1255, when, during the troubles that followed the deposition of the Emperor Frederick II., the tyranny of the nobles had become insupportable. And we have the kindred unions formed under like incentives in Holland. So that, both in small and in large ways, the industrial groups here and there growing up within a nation are, in many cases, forced by local antagonisms partially to assume activities and structures like those which the nation as a whole is forced to assume in its antagonisms with nations around.

Here the implication chiefly concerning us is that, if industrialism is thus checked by a return to militancy, the growth of popular power is arrested. Especially where, as happened in the Italian republics, defensive war passes into offensive war, and there grows up an ambition to conquer other territories and towns, the free form of government proper to industrial life becomes qualified by, if it does not revert to, the coercive form accompanying militant life. Or where, as happened in Spain, the feuds between towns and nobles continue through long periods, the rise of free institutions is arrested; since,

under such conditions, these can be neither that commercial prosperity which produces large urban populations, nor cultivation of the associated mental nature. Whence it may be inferred that the growth of popular power accompanying industrial growth in England was largely due to the comparatively small amount of this warfare between the industrial groups and the feudal groups around them. The effects of the trading life were less interfered with, and the local governing centers, urban and rural, were not prevented from uniting to restrain the general center.

And now let us consider more specifically how the governmental influence of the people is acquired. By the histories of organizations of whatever kind, we are shown that the purpose originally subserved by some arrangement is not always the purpose eventually subserved. It is so here. Assent to obligations rather than assertion of rights has ordinarily initiated the increase of popular power. Even the transformation effected by the revolution of Kleisthenes at Athens took the form of a redistribution of tribes and demes for purposes of taxation and military service. In Rome, too, that enlargement of the oligarchy which occurred under Servius Tullius had for its ostensible motive the imposing on plebeians of obligations which up to that time had been borne exclusively by patricians. But we shall best understand this primitive relation between duty and power, in which the duty is original and the power derived, by going back once more to the beginning.

For when we remember that the primitive political assembly is essentially a war-council, formed of leaders who debate in presence of armed followers ; and when we remember that in early stages all free adult males, being warriors, are called on to join in defensive or offensive actions—we see that, originally, the attendance of the armed freemen is in pursuance of the military service to which they are bound, and that such power as, when thus assembled, they exercise, is incidental. Later stages yield clear proofs that this is the normal order ; for it recurs where, after a political dissolution, political organization begins *de novo*. Instance the Italian cities, in which, as we have seen, the original "parliaments," summoned for defense by the tocsin, included all the men capable of bearing arms : the obligation to fight coming first, and the right to vote coming second. And, naturally, this duty of attendance survives when the primitive assemblage assumes other functions than those of a militant kind ; as witness the before-named fact that among the Scandinavians it was "disreputable for freemen not to attend" the annual assembly ; and the further facts that in France the obligation to attend the hundred-court in the Merovingian period rested upon all full freemen ; that in the Carlovingian period, the "non-attendance is punished by fines and amercements" ; that in England the lower freemen, as well as others,

were "bound to attend the shire-moot and hundred-moot" under penalty of "large fines for neglect of duty"; and that in the thirteenth century in Holland, when the burghers were assembled for public purposes, judicial or other, "any one ringing the town bell except by general consent, and any one not appearing when it tolls, are liable to a fine."

After recognizing this primitive relation between popular duty and popular power, we shall more clearly understand the relation as it reappears when popular power begins to revive along with the growth of industrialism. For here again the fact meets us that the obligation is primary and the power secondary. It is mainly as furnishing aid to the ruler, generally for war purposes, that the deputies from towns begin to share in public affairs. There recurs under a complex form that which at an early stage we see in a simple form. Let us pause for a moment to observe the transition.

As was shown when treating of "Ceremonial Institutions," the revenues of rulers are derived, at first wholly and afterward partially, from presents. Beginning as irregular and voluntary, the making of presents grows periodic and more or less compulsory. The occasions on which assemblies are called together to discuss public affairs (mainly military operations for which supplies are needed) naturally become the occasions on which the expected gifts are offered and received. When by successful wars the militant king consolidates small societies into a large one—when there comes an "increase of royal power in intension as the kingdom increases in extension" (to quote the luminous expression of Professor Stubbs); and when, as a consequence, the quasi-voluntary gifts become more and more compulsory, though still retaining such names as *donum* and *auxilium*—it generally happens that these exactions, passing a bearable limit, lead to resistance: at first passive and in extreme cases active. If by consequent disturbances the royal power is much weakened, the restoration of order, if it takes place, is likely to take place on the understanding that, with such modifications as may be needful, the primitive system of voluntary gifts shall be reëstablished. Thus, when in Spain the death of Sancho I was followed by political dissensions, the deputies from thirty-two places, who assembled at Valladolid, decided that demands made by the king beyond the customary dues should be answered by death of the messenger; and the need for gaining the adhesion of the towns during the conflict with a pretender led to an apparent toleration of this attitude. Similarly in the next century, during disputes as to the regency while Alfonso XI was a minor, the Cortes at Burgos demanded that the towns should "contribute nothing beyond what was prescribed in" their charters. Kindred causes wrought kindred results in France; as when, by an insurrectionary league, Louis Hutin was obliged to grant charters to the nobles and burgesses of Picardy and of Normandy, renouncing the right of

imposing undue exactions; and as when, on sundry occasions, the States-General was assembled for the purpose of reconciling the nation to imposts levied to carry on wars. Nor must its familiarity cause us to omit the instance furnished by our own history, when, after preliminary steps toward that end at St. Alban's and St. Edmund's, nobles and people at Runnymede effectually restrained the king from various tyrannies, and, among others, from that of imposing taxes without the consent of his subjects.

And now what followed from arrangements which, with modifications due to local conditions, were arrived at in several countries under similar circumstances? Evidently, when the king, hindered from enforcing unauthorized demands, had to obtain supplies by asking his subjects, or the more powerful of them, his motive for summoning them, or their representatives, became primarily that of getting these supplies. The predominance of this motive for calling together national assemblies may be inferred from its predominance, previously shown in connection with local assemblies; as instance a writ of Henry I concerning shire-moots, in which, professing to restore ancient custom, he says: "I will cause those courts to be summoned when I will for my own sovereign necessity, at my pleasure." To vote money is therefore the primary purpose for which chief men and representatives are assembled.

From the ability to prescribe conditions under which money will be voted, grows the ability, and finally the right, to join in legislation. This connection is vaguely typified in early stages of social evolution. Making gifts and getting redress go together from the beginning. As was said of Gulab Singh, when treating of presents, "even in a crowd one could catch his eye by holding up a rupee and crying out, 'Maharajah, a petition.' He would pounce down like a hawk on the money, and, having appropriated it, would patiently hear out the petitioner." I have in the same place given further examples of this relation between yielding support to the governing agency and demanding protection from it; and the examples there given may be enforced by such others as that, among ourselves in early days, "the king's court itself, though the supreme judicature of the kingdom, was open to none that brought not presents to the king," and that, as shown by the exchequer rolls, every remedy for a grievance or security against aggression had to be paid for by a bribe; a state of things which, as Hume remarks, was paralleled on the Continent.

Such being the primitive connection between support of the political head and protection by the political head, the interpretation of the actions of parliamentary bodies, when they arise, becomes clear. Just as, in rude assemblies of king, military chiefs, and armed freemen, preserving in large measure the original form, as those in France during the Merovingian period, the presentation of

gifts went along with the transaction of public business, judicial as well as military—just as, in our own ancient shire-moot, local government, including the administration of justice, was accompanied by the furnishing of ships and the payment of "a composition for the feorm-fultum, or sustentation of the king"—so when, with successful resistance to excess of royal power, there came assemblies of nobles and representatives summoned by the king, there reappeared on a higher platform these simultaneous demands for money on the one side and for justice on the other. We may assume it as certain that, with an average humanity, the conflicting egoisms of those concerned will be the main factors; and that on each side the aim will be to give as little, and get as much, as circumstances allow. France, Spain, and England yield examples which unite in showing this.

When Charles V of France, in 1357, dismissing the States-General for alleged encroachments on his rights, raised money by further debasing the coinage, and caused a sedition in Paris which endangered his life, there was, three months later, a reconvocation of the states, in which the petitions of the former assembly were acceded to, while a subsidy for war purposes was voted. And, of an assembled States-General in 1366, Hallam writes, "The necessity of restoring the coin is strongly represented as the grand condition upon which they consented to tax the people, who had been long defrauded by the base money of Philip the Fair and his successors." Again, in Spain the incorporated towns, made liable by their charters only for certain payments and services, had continually to resist unauthorized demands; while the kings, continually promising not to take more than their legal and customary dues, were continually breaking their promises. In 1328 Alfonso XI "bound himself not to exact from his people, or cause them to pay, any tax, either partial or general, not hitherto established by law, without the previous grant of all the deputies convened to the Cortes." And how little such pledges were regarded is shown by the fact that, in 1393, the Cortes who made a grant to Henry III annexed the condition that—

> he should swear before one of the archbishops not to take or demand any money, service, or loan, or anything else of the cities and towns, nor of individuals belonging to them, on any pretense of necessity, until the three estates of the kingdom should first be duly summoned and assembled in Cortes according to ancient usage.

Similarly in England during the time when parliamentary power was being established. While, with national consolidation, the royal authority had been approaching to absoluteness, there had been, by reaction, arising that resistance which, resulting in the Charter, subsequently initiated the prolonged struggle between the king trying to break through its restraints and his subjects trying to maintain and strengthen them. The twelfth article of the Charter having

promised that no scutage or aid, save those which were established, should be imposed without consent of the national council, there perpetually recurred, both before and after the expansion of Parliament, endeavors on the king's part to get supplies without redressing grievances, and endeavors on the part of Parliament to make the voting of supplies contingent on fulfillment of promises to redress grievances.

On the issue of this struggle depended the establishment of popular power, as we are shown by comparing the histories of the French and Spanish Parliaments with that of the English Parliament. Quotations above given prove that the Cortes originally established, and for a time maintained, the right to comply with or to refuse the king's requests for money, and to impose their conditions; but they eventually failed to get their conditions fulfilled.

> In the struggling condition of Spanish liberty under Charles I, the Crown began to neglect answering the petitions of Cortes, or to use unsatisfactory generalities of expression. This gave rise to many remonstrances. The deputies insisted, in 1523, on having answers before they granted money. They repeated the same contention in 1525, and obtained a general law, inserted in the Recopilacion, enacting that the king should answer all their petitions before he dissolved the assembly. This, however, was disregarded as before.

And thereafter rapidly went on the decay of parliamentary power. Different in form, but the same in nature, was the change which occurred in France. Having at one time, as shown above, made the granting of money conditional on the obtainment of justice, the States-General was induced to surrender its restraining powers. Charles VII

> obtained from the states of the royal domains which met in 1439 that they [the tailles] should be declared permanent, and from 1444 he levied them as such—i. e., uninterruptedly and without previous vote. . . . The permanence of the tailles was extended to the provinces annexed to the crown, but these preserved the right of voting them by their provincial states. . . . In the hands of Charles VII and Louis XI the royal impost tended to be freed from all control. . . . Its amount increased more and more.

Whence, as related by Dareste, it resulted that, "when the *tailles* and *aides* . . . had been made permanent, the convocation of the States-General ceased to be necessary. They were little more than show assemblies." But, in our own case, during the century succeeding the final establishment of Parliament, continued struggles necessitated by royal evasions, trickeries, and falsehoods, brought an increasing power to withhold supplies until petitions had been attended to.

Admitting that this issue was furthered by the conflicts of political factions, which diminished the coercive power of the king, the truth to be emphasized is that the increase of a free industrial popula-

tion was its fundamental cause. The calling together knights of the shire, representing the class of small land-owners, which preceded on several occasions the calling together deputies from towns, implied the growing importance of this class as one from which money was to be raised ; and, when deputies from towns were summoned to the Parliament of 1295, the form of summons shows that the motive was to get pecuniary aid from portions of the population which had become relatively considerable and rich. Already the king had on more than one occasion sent special agents to shires and boroughs to obtain subsidies from them for his wars. Already he had assembled provincial councils formed of representatives from cities, boroughs, and market-towns, that he might get from them votes of money. And, when the great Parliament was called together, the reason set forth in the writs was, that wars with Wales, Scotland, and France, were endangering the realm ; the implication being that the necessity for obtaining supplies led to this recognition of the towns as well as the counties.

So, too, was it in Scotland. The first known occasion on which representatives from burghs entered into political action was when there was urgent need for pecuniary help from all sources—namely, "at Cambuskenneth, on the 15th day of July, 1326, when Bruce claimed from his people a revenue to meet the expenses of his glorious war and the necessities of the state, which was granted to the monarch by the earls, barons, burgesses, and free tenants, in full Parliament assembled."

In which cases, while we are again shown that the obligation is original, and the power derived, we are also shown that it is the increasing mass of those who carry on life by voluntary coöperation instead of compulsory coöperation—partly the rural class of small freeholders, and still more the urban class of traders—which initiates popular representation.

Still there remains the question, How does the representative body become separate from the consultative body? Retaining the primitive character of councils of war, national assemblies are at first mixed. The different "arms," as the estates were called in Spain, form a single body. Knights of the shire, when first summoned, acting on behalf of numerous smaller tenants of the king, owing military service, sit and vote with the greater tenants. Standing, as towns originally do, very much in the position of fiefs, those who represent them are not unallied, in legal *status*, to feudal chiefs ; and, at first assembling with these, in some cases remain united with them, as appears to have been habitually the case in France and Spain. Under what circumstances, then, do the consultative and representative bodies differentiate? The question is one to which there seems to be no very satisfactory answer.

Quite early we may see foreshadowed a tendency to part, determined by unlikeness of functions. In the Carlovingian period in France there were two annual gatherings: a larger, which all the armed freemen had a right to attend; and a smaller, formed of the greater personages and deliberating on more special affairs.

> If the weather was fine, all this passed in the open air; if not, in distinct buildings. . . . When the lay and ecclésiastical lords were . . . separated from the multitude, it remained in their option to sit together, or separately, according to the affairs of which they had to treat.

And that unlikeness of functions is the cause of separation we find evidence in other places and times. Describing the armed national assemblies of the Hungarians, originally mixed, Lévy writes: "La dernière réunion de ce genre eut lieu quelque temps avant la bataille de Mohacs; mais bientôt après, la diète se divisa en deux chambres: la table des magnats et la table des députés." In Scotland, again, in 1367–'68, the three estates having met, and wishing, for reasons of economy and convenience, to be excused from their functions as soon as possible, "elected certain persons to hold parliament, who were divided into two bodies, one for the general affairs of the king and kingdom, and another, a smaller division, for acting as judges upon appeals." In the case of England we find that though, in the writs calling together Simon de Montfort's Parliament, no distinction was made between magnates and deputies, yet when, a generation after, Parliament became established, the writs made a distinction, "counsel is deliberately mentioned in the invitation to the magnates, action and consent in the invitation to representatives." Indeed, it is clear that since the earlier-formed body of magnates was habitually summoned for consultative purposes, especially military, while the representatives afterward added were summoned only to grant money, there existed from the outset a cause for separation. Sundry influences conspired to produce it. Difference of language, still to a considerable extent persisting and impeding joint debate, furnished a reason. Then there was the effect of class-feeling, of which we have definite proof. Though in the same assembly, the deputies from boroughs "sat apart both from the barons and knights, who disdained to mix with such mean personages"; and probably these deputies themselves, little at ease in presence of imposing superiors, preferred sitting separately. Moreover, it was customary for the several estates to submit to taxes in different proportions; and this tended to entail consultation among the members of each body by themselves. Finally, we read that "after they (the deputies) had given their consent to the taxes required of them, their business being then finished, they separated, even though the Parliament still continued to sit, and to canvass the national business." In which last fact we are clearly shown that, though aided by other causes, unlikeness of duties was the essential cause which at length

produced a permanent separation between the representative body and the consultative body.

Thus at first of little account, and growing in power only because the free portion of the community occupied in production and distribution grew in mass and importance, so that its petitions, treated with increasing respect and more frequently yielded to, began to originate legislation, the representative body came to be that part of the governing agency which more and more expresses the sentiments and ideas of industrialism. While the monarch and upper house are the products of that ancient *régime* of compulsory coöperation, the spirit of which they still manifest, though in decreasing degrees, the lower house is the product of that modern *régime* of voluntary coöperation which is replacing it; and in an increasing degree this lower house carries out the wishes of people habituated to a daily life regulated by contract instead of by *status*.

To prevent misconception, it must be remarked before summing up, that an account of representative bodies which have been in modern days all at once created is not here called for. Colonial Legislatures, consciously framed in conformity with traditions brought from the mother-country, illustrate the genesis of senatorial and representative bodies in but a restricted sense; showing, as they do, how the structures of parent societies reproduce themselves in derived societies, so far as materials and circumstances allow; but not showing how these structures were originated. Still less need we notice those cases in which, after revolutions, peoples who have lived under despotisms are led by imitation suddenly to establish representative bodies. Here we are concerned only with the gradual evolution of such bodies.

Originally supreme, though passive, the third element in the triune political structure, subjected more and more as militant activity develops its appropriate organization, begins to reacquire power when war ceases to be chronic. Subordination relaxes as fast as it becomes less imperative. Awe of the ruler, local or general, and accompanying manifestations of fealty, decrease; and especially so where the *prestige* of supernatural origin dies out. Where the life is rural, the old relations long survive in qualified forms; but clans or feudal groups clustered together in towns, mingled with numbers of unattached immigrants, become in various ways less controllable; while by their habits their members are educated to increasing independence. The small industrial groups, thus growing up within a nation consolidated and organized by militancy, can but gradually diverge in nature from the rest. For a long time they remain partially militant in their structures and in their relations to other parts of the community. At first chartered towns stand substantially on the footing of fiefs, paying feudal dues and owing military service. They form within themselves unions, more or less coercive in character, for mutual protection. They often

carry on wars with adjacent nobles and with one another. They not uncommonly form leagues for joint defense. And, where this semi-militancy of towns is maintained, industrial development and accompanying increase of popular power are arrested.

But, where circumstances have favored manufacturing and commercial activities and growth of the population devoted to them, this, as it becomes a large component of the society, makes its influence felt. The primary obligation to render money and service to the head of the state, often reluctantly complied with, is resisted when the exactions are great; and resistance causes conciliatory measures. There comes asking consent rather than resort to compulsion. If absence of violent local antagonisms permits, then on occasions when the political head, rousing anger by injustice, is also weakened by defections, there comes coöperation with other classes of oppressed subjects. Men originally delegated simply that they may authorize imposed burdens are enabled, as the power behind them increases, more and more firmly to insist on conditions; and the growing practice of yielding to their petitions, as a means to obtaining their aid, initiates the practice of letting them share in legislation.

Finally, in virtue of the general law of organization that difference of functions entails differentiation and division of the parts performing them, there comes a separation. At first summoned to the national assembly for purposes partially like and partially unlike those of its other members, the elected members show a segregating tendency, which, where the industrial portion of the community continues to gain power, ends in the formation of a representative body distinct from the original consultative body.

PHYSICAL EDUCATION.

By FELIX L. OSWALD, M. D.

I.—REMEDIAL EDUCATION.

"We can not buy health; we must deserve it."—Francis Bichat.

"PREVENTION is better than cure and far cheaper," said John Locke, two hundred years ago; and the history of medical science has since made it more and more probable that, in a stricter sense of the word, prevention is the only possible cure. By observing the health laws of Nature, a sound constitution can be very easily preserved, but, if a violation of those laws has brought on a disease, all we can do by way of "curing" that disease is to remove the cause; in other words, to *prevent* the continued operation of the predisposing circumstances.

Suppressing the symptoms in any other way means only to change the form of the disease, or to postpone its crisis. Thus, mercurial salves will cleanse the skin by driving the ulcers from the surface to the interior of the body; opiates stop a flux only by paralyzing the bowels—i. e., turning their morbid activity into a morbid inactivity; the symptoms of pneumonia can be suppressed by bleeding the patient till the exhausted system has to postpone the crisis of the disease. This process, the "breaking up of a sickness," in the language of the old-school allopathists, is therefore in reality only an interrupting of it, a temporary interruption of the symptoms. We might as well try to cure the sleepiness of a weary child by pinching its eyelids, or the hunger of a whining dog by compressing his throat.

Drugs are not wholly useless. If my life depended upon a job of work that had to be finished before morning, and the inclination to fall asleep was getting irresistible, I should not hesitate to defy Nature, and keep myself awake with cup after cupful of strong black coffee. If I were afflicted with a sore, spreading rapidly from my temple toward my nose, I should suppress it by the shortest process, even by deliberately producing a larger sore elsewhere, rather than let the smaller one destroy my eyesight. There are also two or three forms of disease which have (thus far) resisted all unmedicinal cures, and can hardly be trusted to the healing powers of Nature—the *lues venerea*, scabies, and prurigo—because, as Claude Bernard suggests, their symptoms are probably due to the agency of microscopic parasites, which oppose to the action of the vital forces a life-energy of their own, or, as Dr. Jennings puts it, "because art has here to interfere—not for the purpose of breaking up diseased action, but for the removal of the cause of that action, the destruction of an active virus that possesses the power of self-perpetuation beyond the dislodging ability of Nature."

But with those rare exceptions it is better to direct our efforts against the cause rather than the symptoms—i. e., in about ninety-nine cases out of a hundred it is not only the safer but also the shorter way to avoid drugs, reform our habits, and, for the rest, let Nature have her course; for, properly speaking, disease itself is a reconstructive process, an expulsive effort, whose interruption compels Nature to do double work; to resume her operations against the ailment after expelling a worse enemy—the drug. If a drugged patient recovers, the true explanation is that his constitution was strong enough to overcome both the disease and the druggist.

Dr. Isaac Jennings,* the greatest pathologist (or, at least, patho*gnomist*) of our century, was sadly misunderstood, chiefly, I believe, because he called his method the "Let-alone Plan." Prevention Plan, or Unmedicinal Cure, would have been a better word. Diseases do not want to be let alone; they call loudly for relief—not, though,

* Author of the "Treatise on Medical Reform."

from their own symptoms, which, in fact, are so many alarm-signals, but from the obstacle which has forced the vital process to deviate from its normal course. Pain, in all its forms, is an appeal for help, and the urgency of the appeal corresponds to the degree of the distress; probably, also, to the possibility of relieving that distress. A deadly blow stuns—the vital forces yield without a struggle. The last stage of pulmonary consumption is a comparatively painless *deliquium*—when a conflagration grows uncontrollable, the alarm-bells cease to ring. Yellow-fever doctors give up their patients for lost when the burning headache changes into a lethargic stupor. The last sensations of drowning, strangled, and freezing persons are said to be rather pleasurable than otherwise. In certain cases the appeal for help continues into an apparently hopeless stage of the disease. Apparently, I say: Nature is too practical to waste her efforts on a forlorn hope; her resistance yields to necessity; and, when the art of healing shall devote itself to the exegesis of disease rather than to the exorcism of its symptoms, that rule will probably be found to apply to pathology as well as to chemistry and ethics.

All bodily ailments are more or less urgent appeals for help; nor can we doubt in what that help should consist. The more fully we understand the nature of any disease, the more clearly we see that the discovery of the cause means the discovery of the cure. Many sicknesses are caused by poisons, foisted upon the system under the name of tonic beverages or remedial drugs; the only cure is to eschew the poison. Others, by habits more or less at variance with the health laws of Nature; to cure such we have to reform our habits. There is nothing accidental, and rarely anything inevitable, about a disease; we can safely assume that nine out of ten complaints have been caused and can be cured by the sufferers (or their nurses) themselves. "God made man upright"; every prostrating malady is a deviation from the state of Nature. The infant, "mewling and puking in its nurse's arms," is an abnormal phenomenon. Infancy should be a period of exceptional health; the young of other creatures are healthier, as well as prettier, purer, and merrier, than the adults, yet the childhood years of the human animal are the years of sorest sickliness; statistics show that among the Caucasian races men of thirty have more hope to reach a good old age than a new-born child has to reach the end of its second year. The reason is this: the health theories of the average Christian man and woman are so egregiously wrong, that only the opposition of their better instincts helps them—against their conscience, as it were—to maintain the struggle for a tolerable existence with anything like success, while the helpless infant has to conform to those theories—with the above results.

"I have long ceased to doubt," says Dr. Schrodt, "that, apart from the effects of wounds, the chances of health or disease are in our own hands; and, if people knew only half the facts point-

ing that way, they would feel *ashamed* to be sick, or to have sick children."

A vestige of the hygienic insight which in savages appears to be a gift of Nature, would, indeed, almost obviate the necessity of a treatise on the diseases of infancy; nay, wherever people have got rid of four or five of the grossest physiological prejudices, the art of preserving the health of a healthy-born child is even now a sort of intuition with every true mother; but nurses, physicians, and foster-parents, are often called upon to mend the mistakes of their predecessors, and to undertake a task whose less intuitive duties may be facilitated by some of the following hints on remedial education:

Shakespeare's "mewling and puking" representative of babyhood was probably overfed. The representative nurse believes in cramming; babies, like prize-pigs, are most admired when they are ready to die with fatty degeneration. The child is coaxed to suckle almost every half-hour, day after day, till habit begets a morbid appetite, analogous to the dyspeptic's stomach distress which no food can relieve till over-repletion brings on a sort of gastric lethargy.

"Many hand-fed infants, weighing about ten pounds, will swallow one and a half quart of cow's milk in one day," says Dr. Page;* "now, considering the needs of a moderately working man to be equal in proportion to size, a man weighing one hundred and fifty pounds should take fifteen times the quantity swallowed by the infant, or twenty-two and a half quarts—a quart for nearly every hour of the day and night!"

Vomiting, restlessness, and gross fatness, are some of the symptoms of the surfeit-disease, and its proper cure is—not soothing-sirups, but—fasting. Four nursings a day are enough, five more than enough, and the ejection of milk after suckling is a sure sign that the quantity given at each meal should be diminished. A pint of milk a day is about as much as a dyspeptic infant can really digest, and to cram it merely in order to stop its crying is quite mistaking the cause of its restlessness; a half-starved child will not cry, because the languor of insufficient nutrition is a pleasure compared with the gastric torments of the surfeit-disease. Children actually perishing with hunger will utter from time to time a peculiar sharp cry, almost like the call of a hungry nest-bird, but the first mouthful of food makes them relapse into a sort of dreamy silence.

There are nurslings who get at least four times more milk and pap than they can possibly assimilate, and whose digestive organs have to reject the surplus in a way that would make life intolerable to an adult, though most nurses seem to consider retching and "dripping" as a normal phase of infant life.

Drugs only complicate the disorder: many children whose constitution would have resisted the cramming process succumb to opiates, "surfeit-water" and ipecacuanha; but, unless foul dormitories still fur-

* "How to feed a Baby to make it healthy and happy," p. 23.

ther aggravate the evil, each night generally undoes the mischief of the day; the child becomes plethoric with fat; Nature has shifted the burden from the vital organs to the tegumental tissues, and in hopes of final relief manages to hold the fort of life against daily and complicated attacks. Relief comes at last when the nursling is weaned and reduced from ten or twelve to three meals a day. The after-effects of medication may retard recovery for a while, but, the main cause being removed, the morbid symptoms disappear in the course of four or five months.

A less frequent but (through gross maltreatment) often more dangerous disease is scrofula, the cachectic degeneration of the humors resulting from the combined influence of unwholesome food and foul air. In the rural districts of our milk and corn-bread States scrofulous children are as rare as white wolves in the tropics; in Northern Europe the disease is now far less prevalent than formerly; and the operatives of our large cities, in spite of their wretched habitations, might avoid it altogether, or at least obviate its more serious consequences, but for the fatuous quackery which so often turns a transient skin-disease into a chronic lung-complaint. In the middle ages, when science was at its lowest ebb and supernaturalism in full tide, the "king's-evil" was considered an almost unavoidable disease, resisting all common remedies and yielding only to the mandate of royalty—the touch of a legitimate king, supplemented by the mandamus of a clerical exorcist. In the fifteenth century from eight to twelve thousand families per year performed long journeys to the English capital; Charles II, in the course of his reign, touched near a hundred thousand persons. The days on which the miracle was to be wrought were solemnly notified by the clergy of all parish churches (Macaulay's "History of England," Chapter XIV). Traveling was expensive in those days, and, scrofula being distinctively a disease of the poor, nine out of ten patients of the royal doctor had probably come afoot, and often from distances which suggest the explanation of the marvelous cures: the pilgrims left the pest-air of their hovels behind, and Nature availed herself of the respite, as she improves a temporary change from city fumes to the woodland air of some rural retreat whose salubriousness is ascribed to the accidental presence of a nauseous sulphur-spring—the one abnormal thing about the place. The king's-evil patients, as well as the exorcists, ascribed the cure to what Dr. Joel Brown called the *charisma basilicon*—the healing touch of the Lord's anointed—in other words, they believed that the cure of a Yorkshire man's disease depended upon the chance of the Yorkshire man's coming in contact with a Londoner who, perhaps ten or twenty years ago, had undergone the rites of a certain ceremony. Imagination probably helped a little, for after the spread of skepticism "perfect cures became much less frequent," as Dr. Brown naïvely remarks. The *charisma basilicon* has now fallen into utter discredit, but our

present method is so little of an improvement that the patients of a future century would probably prefer to resume the Whitehall pilgrimages. Instead of ventilating our houses and abolishing our sauerkraut (the long-notorious cachexia of the ill-housed and ill-fed classes having sufficiently indicated the cause of the malady), we suppress the morbid symptoms by sarsaparilla, iodide of potassium, or patent "medicines": only reliable liver-pills and infallible blood-purifiers—in other words, we believe that the cure of a common disease depends upon the accidental or providentially ordained discovery of some mysterious compound. The bottom error is the same as in the king's-evil delusion, and can be easily traced to the radical fallacy of our speculative dogmas; we still regard sin and disease as something normal, aboriginal, and unavoidable, and expect salvation from mysterious, extra-natural remedies, while the truth of the very contrary is becoming more and more evident, namely, that all evil, including moral and physical unsoundness, is due, and generally traceable, to wholly abnormal causes, and (those causes being removed) recovery the effect of the self-acting and self-regulating laws of Nature. The removal of the cause is a remedy which the sufferers from almost any disease might prescribe for themselves, and here especially: fresh air and abstinence from indigestible food, particularly pickles and fat meat. Pork is not the only unwholesome kind of animal food, for Jews are not exempt from scrofula, and were formerly subject to a still worse skin-disease; and, if we had not forgotten the art of interpreting the language of our instincts, we would not overlook the significancy of the circumstance that ninety-nine per cent. of all young children detest every kind of fat meat except in the form of taste-deceiving ragouts. Farmer-boys, who have to share the out-door labors of their parents, can eat with *comparative* impunity many things which only the hardiest of their city comrades can digest: pork, greasy and pickled cabbages, fritters, and salt beef. Even young Hottentots could not eat such stuff without being sooner or later the worse for it, whenever the counteracting hardships of a savage life alternate with a period of physical inactivity. But children afflicted with cachectic symptoms should at once be restricted to a wholly vegetable and non-stimulating diet—farinaceous preparations, boiled legumina, and, if possible, ripe, sweet fruit.

The summer diet of a scrofulous child can not be too *frugal*, in the ancient sense of the word, and, where a supply of ripe tree-fruits can be easily obtained, I should think it the best plan to dispense altogether with made dishes—for a while, even with farinaceous dishes. Parents who have no hesitation in cramming their children with salt pork, beer, and sauerkraut, would shudder at the idea of feeding them on fruit alone, yet the happiest of all visitors to the southern Rhineland are probably the patients of a Swabian *Trauben-Kur*, where dyspeptics, etc., are fed almost exclusively—often for days together quite exclusively—on ripe, sweet grapes. Combined with plenty of exercise

in the bracing air of a highland region, the efficacy of the grape-cure surpasses all the miracles of the king's touch. It will cure children, "too scrofulous to look out of their eyes," cheaper and quicker than any nostrums, and has the still greater advantage of eliminating instead of suppressing the virus.

Those who deny the pharmaceutic efficacy of the homœopathic sugar-pellets can not deny that, in this case, homœopathy has proved the possibility of curing diseases without any drugs at all—merely by a change of diet and regimen. Frugality, abstinence, bathing, ventilation, cold water, and exercise in the open air, have already superseded half the *materia* of the old medical dogmatists, and personal experience has convinced me that the following diseases of children are amenable to a strictly hygienic treatment.

ANCIENT COPPER-MINES OF ISLE ROYALE.

By Professor N. H. WINCHELL.

THESE *mines* are rude, irregularly disposed, shallow pits in the general surface, which, on being cleared of rubbish, are found rarely to exceed the depth of ten feet, but in some instances reach the depth of twenty. They seem to have been located by the accidental outcropping of native copper, over large areas the rock being entirely bare. In other cases, the mining seems to have been systematically prosecuted along the strike of a known copper-bearing belt of rock. In this case it is a rock of marked lithological characters, being of a red color, and, when once its trend was established by a series of pits, it was followed under the drift-materials, that were thrown off into heaps, in which are found, mingled with charred wood and other relics, a great many stone hammers. In one instance, a cross-drift ran under a rude archway from one red belt to another, through a thin partition of darker rock; but, in general, no planning for easy excavation or skillful and prolonged effort in the operations of the miners can be discovered. So far as can be ascertained, they resorted to the very simplest and most laborious methods of excavation in the rock, using their stone hammers, wielded in the hands alone, sometimes aided perhaps by the application of heat, and by repeated blows battered and broke away the rock surrounding the copper masses. When once a mass was detached or sufficiently uncovered, it was parted into smaller pieces by the same means. Some of the masses found, being too large for removal from the pits, show the marks of long-continued pounding, and about them in the pits are a great many small, thin chips of metallic copper, of irregular shapes, with concavo-convex surfaces, exactly such as would be produced by battering a small nugget of

copper to a thin layer by pounding it continuously on the same side. The finding of these thin chips of copper is the first indication to the present miners of the proximity of a large mass. In the summer of 1874 the first of these large masses was discovered. It was sixteen and one half feet below the surface, and under it were poles, as if it had been entirely detached, but it had not been much displaced. This mass was exhibited publicly in the yard of the court-house at Detroit, and was also on exhibition at the Centennial Exposition in 1876. It was subsequently fused and sold as commercial copper. It weighed 5,720 pounds, and has been described by Mr. Henry Gillman, in the annual volume of the American Association for the Advancement of Science for 1875. In the summer of 1879 two other large masses that had been wrought by the ancients were found at the Minong Mine, which is at the head of McCargoe's Cove. One had a weight of 3,317 pounds, and the other 4,175 pounds, the latter being about nine feet long. The largest mass yet found at that place was taken out the previous summer, weighing six tons, but the ancients had not discovered it, though one of their drifts ran within two feet of it. The large masses discovered by the ancients show the labor that has been spent on them in their hammer-marked and pitted surfaces. They seem to have been beaten up into ridges and points, by hammering alone, for the easier removal of parts. One of those found in 1879 was not detached from the inclosing rock, though it was wholly uncovered and undermined. A restoration of its appearance, as represented by Captain William Jacka, is seen in Fig. 1.

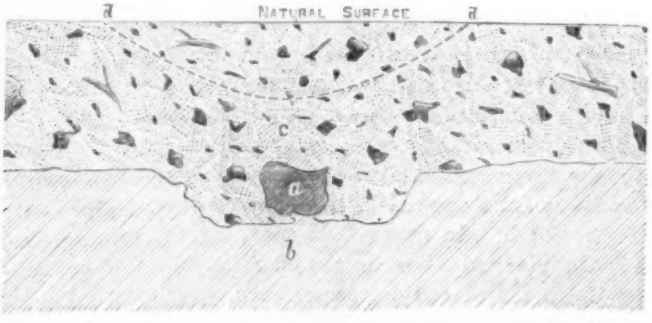


FIG. 1.—*a*, mass of copper; *b*, the inclosing rock; *c*, layer of drift excavated, twelve feet thick; *d d*, line showing surface of the ancient pit before reëxcavation.

Various articles have been found in these old pits or in their neighborhood. Several copper implements, such as a gad, a chisel, knives, and arrow-heads, have been discovered, both on Isle Royale and in the vicinity of similar old mines on the south shore of Lake Superior. Mr. Gillman reports that a large part of a "wooden bowl," originally about three feet in diameter, which had probably been used for boiling water, was taken from one of these pits. The timber found in some

of these excavations bore the marks of an axe, the bit of which must have been about two inches in width. Fragments of charcoal and partially consumed sticks abound. The bark of the white birch is still preserved, though the interior woody portion is wholly rotted. At McCargoe's Cove, Captain William Jacka discovered a wooden shovel or paddle, which showed by its worn and battered side that it had been used in moving dirt. The blade was four and three quarters inches wide, and about twelve inches long. The handle had been broken, but still showed the length of about a foot. It was all perfectly wrought and smooth, and very true in form. A rounded ridge on the upper and lower sides of the blade extended along its middle, tapering off along the same sides of the shaft or handle upward. It was wet and swollen when found, but, on drying, it shrank to a width of three fourths of an inch, and curled out of shape. A restoration of this ancient paddle or shovel is seen in Fig. 2, as drawn under the direc-

FIG. 2.—ANCIENT PADDLE, USED BY THE MINERS ON ISLE ROYALE FOR MOVING DIRT.

tion of Captain William Jacka, and a cross-section of the blade in Fig. 3 : *a* represents the upper side of the blade, and the ridge, evidently designed to strengthen the instrument, extends to within an inch or two of the end, and gradually and smoothly sinks to the level of the surface. This shovel was found within a few feet of one of the large masses of copper, in the summer of 1879.

Dr. G. K. Gailey also discovered a piece of string, about a foot long, made of some raw-hide, supposed to be of the caribou, tied in the mid-

FIG. 3.—TRANSVERSE SECTION OF THE BLADE OF ANCIENT MINER'S TOOL, FROM ISLE ROYALE.

dle by "a square knot and a half-hitch." This lay under one corner of the copper mass found in May last (1879), and seemed to break on being pulled out, but the remainder could not be secured. When examined, this string seemed to possess the fiber and much of the strength of dried raw-hide, a circumstance that will not allow the assignment of a very great antiquity to the date of the last mining. Caribou were on the island till a few years ago, and are now common on the shore directly north of the island.

In regard to the main implements of the mines, the stone hammers, they seem not to have been made for the purpose for which they were used. Great numbers of them are found in moving the dirt which the miners handled. They are of various sizes and forms, but generally

about five inches in diameter, though some are eight and even ten inches, and of a rounded oval outline. They were certainly gathered as pebbles along the shore of the lake, north from the island, where there are still others of the same shapes and sizes, and of the same varieties of

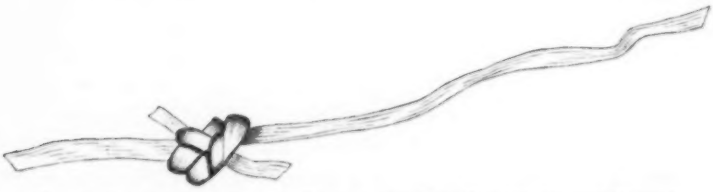


FIG. 4.—RAW-HIDE STRING AND KNOT OF THE ISLE ROYALE ANCIENT MINERS.

rock, formed on the beach by the action of the waves. The great profusion in which they are scattered among the *débris* of the pits would itself indicate the ease with which they were obtained. They are not grooved for the reception of a withe, like those found on the south shore, near Ontonagon, but they were apparently used for the most part by simply swinging them in the hand, or probably in both hands clasped, thus by repeated blows breaking away the surrounding rock or hammering the desired metal into such shapes as to facilitate its separation in smaller pieces. The rock of which they are composed does not occur as pebbles on Isle Royale, and indeed it is doubtful if it exists at all on the island. It forms the coast of the mainland for several miles opposite the island. It is an igneous rock, usually a diabase, as shown in thin sections under the microscope, consisting essentially of a triclinic feldspar and augite, with magnetite. Sometimes the grains are coarser, and the rock would more properly be styled a dolerite or a gabbro. They belong to the formation designated by Sir William Logan *The Lower Volcanic Group*, but since styled *Animikie Group*, by Professor T. S. Hunt.* Occasionally, however, the workmen seem to have gathered rounded stones of other varieties of rock, though nothing equaling the firmness of the above, and so fit for the purpose of a rude hammer in simple mining, can be selected among all the rocks of the region. One or two, of a granite containing red orthoclase, were seen at the mine, and a few of other granites are reported to have been found. These other varieties are also seen mingled sparsely with the diabase stones along the Canadian shore, and are referable to the drift forces which transported them from farther north and east in Canadian territory.

Although these hammers, as a rule, are not withed, it is still true that occasionally one is found that is withed—i. e., grooved for the reception of a withe handle. One seen at the time of this visit was owned by Dr. Gailey, and was not well wrought. The groove was evidently

* *Vide* "Trap Dikes and Azoic Rocks of Southeastern Pennsylvania," "Second Geological Survey of Pennsylvania," pp. 68, 240.

made by an unskilled hand, and was unfinished. This allies these miners with those of the south shore of the lake. The absence of these hard, rounded stones on the shores of the south side of Lake Superior,* owing to the strike of the formation producing them across the interior of the States of Michigan and Wisconsin, made it necessary for the miners on that side to manufacture their hammers, which they did with greater perfection and symmetry than are seen in the beach-wrought hammers of the Isle Royale miners; and they almost invariably grooved them for a withe. Those found on Isle Royale are generally broken with use on one end or on both, a fact which probably caused their abandonment. Fig. 5 shows the imperfectly grooved

FIG. 5.—IMPERFECTLY WITHED HAMMER, FROM THE ANCIENT MINES OF ISLE ROYALE.

hammer belonging to Dr. Gailey. Fig. 6 shows the outline and irregularity of three others, also found at the Minong mine. These are a fair average for form, of the most of those found. They are also evidently such as would result from the constant attrition of angular fragments on the beach, and show no evidence of designed shaping.

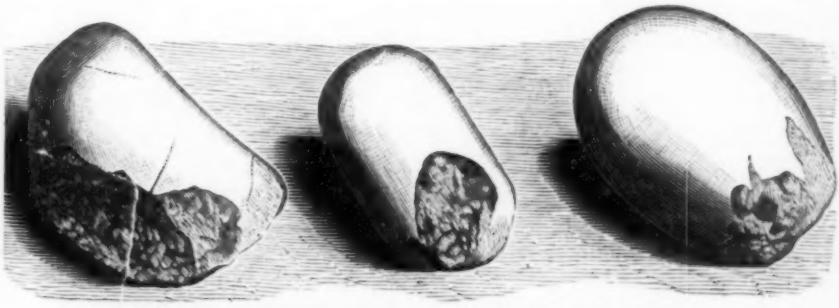


FIG. 6.—STONE HAMMERS FROM THE ANCIENT MINES OF ISLE ROYALE.

Their battered and even fractured extremities are the only sign of the agency of man in giving them shape.

If we inquire now who were the men, and when did they live, who did this work, we enter on a very interesting question, but one on which we are not in total darkness. A single observation at the pits at once places them *later than the last glacial epoch.* The dirt that

* Ship-loads of these stones are transported from the north shore of Lake Superior for paving streets in Chicago and other cities.

they moved lies on the drift-clay. This is shown by the subjoined diagrammatic sketch taken on the spot (Fig. 7). It is also shown by the fact that some of the pits are but a few feet above the present lake-level (about thirty feet); since during the period of the drift, and particularly toward its close, the interior lakes and rivers of the North American Continent were much higher than they are now.

It has been agreed for some years, by American archæologists, that

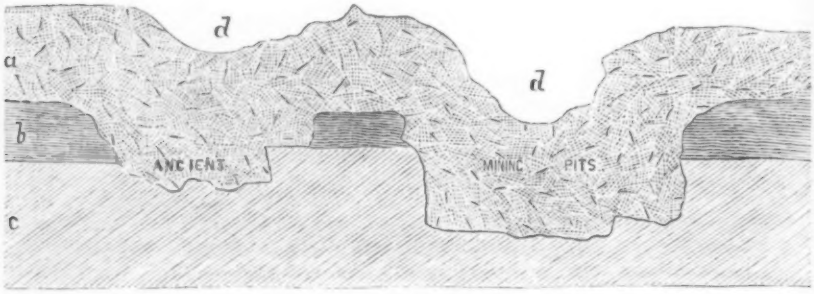


FIG. 7.—EXPLANATION.

a, chips and moved earth in which the stone hammers are found; *b*, the modified drift-clay; *c*, the cupriferous rock; *d d*, depressions in the surface indicating the location of the ancient pits, sometimes refilled by the old miners.

the ancient miners of Lake Superior were identical with the mysterious race known as the mound-builders. The evidence of this, first partially elucidated by Messrs. Squier and Davis, has multiplied by subsequent observations, so that there is now a concurrent series of facts pointing to that conclusion. It consists largely in the discovery of many copper implements in the mounds that have been opened. These implements sometimes contain small nuggets of metallic silver closely welded to the copper. At no other place in the United States are copper and silver found thus naturally combined. They must have been pounded into shape, since the melting of the copper for casting would certainly have produced an alloy in which the appearance of the silver would be entirely lost. This, taken in connection with the well-established mining methods of the Isle Royale miners, undeniably identifies them with the mound-builders.

If we inquire further what relation the mound-builder bore to the aborigines found here by Columbus, we shall be compelled to admit from the evidence that *the aborigines themselves were the mound-builders and the ancient miners.* As this conclusion is at variance with the generally accepted opinion, it will be necessary to consider some of the characteristics of the mound-builders, as stated by the highest authorities, and to compare them with the known peculiar habits and customs of the Indians:

1. Squier and Davis state that "there probably existed among the mound-builders a state of society something like that which prevailed among the Indians; each tribe had its separate seat, maintaining, with

its own independence, an almost constant warfare against its neighbors" ("Smithsonian Contributions," vol. i, p. 44).

2. The mound-builders occupied the entire country from Lake Superior, at least,* on the north, to the Gulf of Mexico on the south, and from the Alleghanies, at least, on the east, to the Sierras on the west. This is demonstrated not so much by the distribution of the mounds—though they are said by Lewis and Clark to occur on the upper waters of the Missouri, and, by Mr. A. Barrandt, in the valley of the Yellowstone—as by the existence of copper implements from Lake Superior in the same mounds with mica from the Alleghanies, pearls from the Gulf shores and from the Carolinas, and sharks' teeth from the cretaceous beds of the South and West.

3. They were an agricultural people, of generally homogeneous customs, habits, religion, and government, each tribe carrying on a trade with surrounding tribes, and some of them with distant tribes.

4. They worked copper in a cold state, having no knowledge of iron, nor of the methods of smelting any of the ores of the metals by the aid of fire.

5. They built extensive earthworks and mounds, both for purposes of warfare and for sepulture.

6. They exhibited very frequently a remarkable flattening of the shin-bone (*platycnemism*).

7. They made a coarse kind of cloth, by twisting and weaving the fibers and bast of various plants.

8. They made pottery of clay, which they hardened by burning, and rudely ornamented with figures of animals, or by simpler lining.

9. They wrought stone, making axes, arrow and spear heads, knives, wedges, pestles, discoidal stones, tubes, pipes, beads; and they had a high regard for mirrors of mica.

10. They made rude sculptures, in stone and burned clay, of animals and of the human face.

11. They had no knowledge of writing by the use of an alphabet, nor hieroglyphics; but sometimes resorted to pictures to convey information.

12. They employed shells, pearls, sharks' teeth, obsidian, copper, silver, steatite, black and mottled slate, mica, coralline limestone, the bones of some animals, and some other minerals, especially galena and hematite, for making articles of personal adornment.

13. Besides rude sculptures of most of the present animals of the larger types, the elephant (or mastodon) was also known to them, as evinced by the "elephant-mound" in western Wisconsin, by the dis-

* Along the boundary-line between Minnesota and the Canadian territory are occasional mounds. One very large one is on the Canadian side of Rainy Lake River, at the Big Sioux Rapids (N. Butler). They are found near Grand Marais, on the north shore of Lake Superior.

coveries of Dr. Koch in Missouri, and by the "elephant-pipe" lately brought to light in Louisa County, Iowa.*

Some of these characteristics it is only necessary to name, to enable any one to recognize also their belonging to the red-men who were here when Columbus discovered America, and who probably are identical with the *Skrellings* seen by the Norse adventurer, Thorwald Ericson, in 1002, described as having sallow-colored, ill-looking faces, ugly heads of hair, large eyes, and broad cheeks, coming to his ship in canoes for purposes of trade, but becoming hostile and treacherous. The various tribes into which the red-men were, and still are, divided, extended over the whole territory that is known to have been occupied by the mound-builders.

That they were an agricultural people, although given to warlike expeditions, and to long journeys for the purpose of trade and for rice-gathering and hunting, is also abundantly attested by the journals of the earliest explorers. Of these it is only necessary to refer to those of Hudson and Juet in the Half-Moon, who mention in several places the existence of extensive cultivated fields along the banks of the Hudson, and to the historians of De Soto's expedition, who speak frequently of Indian villages containing from fifty to six hundred dwellings, substantially constructed of wood, in which must have dwelt upward of two thousand persons. They frequently mention, also, extensive fields of corn, beans, pumpkins, and other vegetables. In one instance De Soto's army traveled two leagues through fields of corn, and sometimes large quantities of corn and of meal were obtained from the houses (*vide* Irving's "Conquest of Florida").

The fact that the aborigines worked stone, using stone axes, arrow-heads, disks, wedges, hammers, pestles, and scrapers, is authenticated not only by the testimony of early writers, but also by the continuance of the same custom nearly if not quite up to the present time among some of the most inaccessible tribes of North America, though they have almost wholly ceased to be used, in consequence of the metallic implements furnished them by the whites.

The manner of making pottery among the Mandan Indians is described in detail by Catlin, who states that "earthen dishes are made by the Mandan women in great quantities, and modeled in a thousand forms and tastes," and that they are nearly equal in hardness to our own manufactured pottery, though they knew not the art of glazing. Fragments of pottery, evidently made by these Indians, are found about Bismarck, in Dakota, and on the Heart River, and in various parts of northern Minnesota, where it was doubtless made by the Chippewas; and they greatly resemble the pottery taken from the mounds, being unglazed, gray, slightly baked or unbaked, and somewhat ornamented by lines and figures.

The articles of cloth that have been found in the mounds are made

* John T. Short, "The North Americans of Antiquity," p. 530.

of the bast-fibers of certain plants, and have been preserved by "the antiseptic action of the salts of copper," the cloth having been wrapped about copper axes and nuggets prior to being placed in the mounds.* It appears to be "a kind of hemp, possibly the *Apocynum cannabinum*, formerly used by the Aztecs," or perhaps, as suggested by Colonel D. A. Robertson, of St. Paul, the fibers of *Urtica gracilis*. Cloth of equal fineness is still made by several of the Indian tribes, particularly by the Navajoes of New Mexico; and nearly all of the tribes are known to have had mats and even carpets, woven of various sedges or of bast-fibers. They are still made by the Chippewa Indians in northern Minnesota.

The sculptured objects taken from the mounds, even those of the human face, are generally cut in some very soft stone, or are made of clay. They are equaled in skill and design by the sculptured pipes

FIG. 8.—From photograph of an image found in the valley of Root River, near Lanesboro, Minnesota, April, 1880. The mound from which it was taken also contained stone arrow-heads, one copper ditto, clay-burned pipes, among the remains of a large number of human skeletons. The image was evidently made of clay burned to be very hard. The back or reverse side is nearly flat. The nose is partly broken off.

and hatchets the Indians have been known to make ever since the Columbian discovery, and particularly by those made of the famous red pipestone or Catlinite † of Minnesota. As illustrative of the sculpture of the mound-builders, Fig. 8 is here presented. This is from a photograph of a representation of the human face taken from a mound

* R. J. Farquharson, "Recent Explorations of Mounds near Davenport, Iowa," "Proceedings of the American Association for the Advancement of Science," vol. xxiv, p. 305.

† Mr. Farquharson ("American Association for the Advancement of Science," vol. xxiv, p. 306) speaks of a green variety of *Catlinite*, which, on the contrary, is always red. Other American archæologists have in the same way spoken of *Catlinite* (?) pipes found in the mounds, but which by the descriptions given are precluded from being *Catlinite*. The Chippewa Indians of Minnesota make pipes of a greenish argillitic slate, obtained near

lately opened at Lanesboro, in Fillmore County, Minnesota. For this I am indebted to the kindness of Mr. H. G. Day, who states that the image was found in the same mound with stone arrow-heads, one copper arrow-head, clay-burned pipes, and the remains of a large number of human skeletons. This piece of burned clay, about three inches in height, represents the human face, and is certainly not evidence of greater skill than the Mandan pottery made by the women of that tribe, but shows that the burning of clay was a practice common to both peoples.

There was a time, recently, when the flattening of the shin-bone was claimed to be a striking peculiarity of the mound-builders. This view was very fully set forth by Mr. Henry Gillman, in his papers on the contents of several Michigan mounds, particularly those on the Rouge and Detroit Rivers, explored by him in 1869 and 1870 ("Smithsonian Report," 1873). This view has also been advocated by Dr. A. E. Johnson, before the Minnesota Academy of Sciences, in a description of bones taken from a mound at Palmer Lake, near Minneapolis. If this distinction could be fully established, it would be one of the most valuable and one of the most remarkable ethnological discoveries of American scientists, and would form a basis for future investigations that might fully establish the distinctness of the mound-builder among the dynasties of North America. But, according to Mr. Gillman's own observations, made at a later date, this peculiarity is not uniform nor constant in the tibiæ taken from the Michigan mounds, and in some mounds it is wanting. The same is true of the perforation of the humerus, which has also been regarded as peculiar to the mound-builder. Of six humeri taken by the writer from mounds at Big Stone Lake, Minnesota, but one was perforated. Both these osteological variations are found occasionally in the present Indian, and the former is very common in the negro and in the ape. Dr. Jeffries Wyman informs us, according to Professor J. D. Dana, that the platycnemic tibia is a common fact among the American Indians, as well as in the prehistoric remains of Europe. More lately a platycnemic tibia from the Lanesboro mound was submitted to Professor Leidy, of Philadelphia, who, in reply to a question as to its significance, stated that it was now regarded as of no special significance, but was a common occurrence in the early races.*

We come now to consider the most interesting as well as the most difficult points in the genetic relationship of the Indian and the mound-builder. These are the existence of the mounds, the mining

the international boundary, but the Sioux use the *Catlinite* of the celebrated pipestone region, in southwestern Minnesota. By trade the *Catlinite* sometimes finds its way into the northern part of the State, and is employed as inlaid ornaments in the dark slate, in the same manner as lead is used for a similar purpose.

* For a knowledge of this correspondence I am indebted to Rev. E. D. Neill, of the Minnesota Historical Society.

of copper, and the use of copper implements. The Indian, it is said, knows nothing of the mound—that is, nothing of its origin. He also avers, at the present time, that he knows nothing about the copper knives, axes, and arrow-points that are shown him. This fact, taken with a sentiment that has exalted the builders of the mounds to a stage of civilization far in advance of that evinced by the commonalty of the savage races of North America as they exist in the eighteenth and nineteenth centuries, has erected a barrier between the Indian and the mound-builder, which, though wholly imaginary when subjected to close analysis, is so great that they have been regarded either as misinformed, or rash, who have ventured to question its validity. Messrs. Squier and Davis, who first systematically explored and described the remarkable mounds of the Ohio Valley, were led to regard the mound-builders as a race wholly distinct from the Indian ("Smithsonian Contributions to Knowledge," vol. i, 1848), and this view is also maintained by the beautiful and able work of Mr. John T. Short ("The North Americans of Antiquity," 1880). Mr. Squier, however, in his work on the "Aboriginal Monuments of the State of New York" ("Smithsonian Contributions," vol. ii), in 1849, mentions many points of resemblance between the mound-builder and the Indian, though he does not specifically state that the Ohio Valley earthworks are probably of Indian origin, while he does conclude that the mounds and earthworks of western New York, as well as their contents, are the product of the Iroquois. Mr. Lapham, in vol. vii of the "Smithsonian Contributions," unhesitatingly ascribes the mounds and the copper-mining to the Indians, but his opinion has been generally ignored. Colonel J. W. Foster, in "Prehistoric Races of the United States," makes light of Mr. Lapham's views.

Upon consulting a number of works in the library of the Minnesota Historical Society that bear on this subject, it is found that there are a great many more references to the use of copper by the Indians, and to their knowledge of its origin, than has generally been supposed. They are too numerous and circumstantial, and are spread over too wide a stretch of time, to be supposed to be exceptional.

Following are a few quotations from early journals and histories that seem to demonstrate not only that the Indians used and mined native copper, but that they also erected mounds of earth, or of stones, in commemoration of their honored dead, and for sepulture. The Indian is a dull utilitarian. He is but little given to sentiment. As he knows nothing of the future, so he remembers little of the past. Hope and history are alike feeble in his mental garniture. His traditions are worthless, and "his chronology of moons and cycles is an incoherent and contradictory jumble."* If he says he knows nothing of these relics, his testimony can apply only to himself personally, for his ancestors, on the most undeniable evidence, did know all about them.

* Short, "The North Americans of Antiquity," p. 22.

In regard to the use of copper, and the mining of it, by the American aborigines, may be made the following quotations and references:

In the "Collections of the New York Historical Society," second series, vol. i, is given a translation of the Italian account of the voyage of John de Verazzano along the coast of North America, from Carolina to Newfoundland, A. D. 1524. When about at Narragansett Bay and Harbor he makes these notes: "We saw upon them [the aborigines] several pieces of wrought copper, which is more esteemed by them than gold, as this is not valued on account of its color, but is considered by them as the most ordinary of the metals, yellow being the color especially disliked by them; azure and red are those in highest esteem by them." Further on he says of another tribe: "In this region we found nothing extraordinary except vast forests and some metalliferous hills, as we infer, from seeing that many of the people wore copper ear-rings."

Henry Hudson's ascent of the river that bears his name is given in the same volume, in the form of a journal kept by Robert Juet, mate. Speaking of the natives, on page 323, Juet says: "They had red copper tobacco-pipes, and other things of copper they did wear about their necks"; also, "They have great tobacco-pipes of yellow copper"; also, on page 300, Hudson himself says, "The people had copper tobacco-pipes, from which I inferred that copper might naturally exist there."

Raleigh observed copper ornaments among the Indians on the coast of the Carolinas; Granville, in his voyage in 1580, observed copper in the hands of the natives of Virginia, and made an effort to reach the place where they said it was obtained. After a toilsome journey into the interior, of some days' duration, the attempt was abandoned. Heriot's "Voyage," in Pinkerton, vol. xii, p. 594, gives an account of copper found "in two towns one hundred and fifty miles from the main, in the form of divers small copper plates, that are made, we are told by the inhabitants, by people who dwell farther in the country, where they say are mountains and rivers which yield white grains of metal which are deemed to be silver. For confirmation whereof, at the time of our first arrival in the country, I saw two small pieces of silver, grossly beaten, about the weight of a tester [an old coin about the weight of a dime], hanging in the ears of a Wiroance. The aforesaid copper we found to contain silver." McKenzie found copper in use among some of the extreme northern tribes, on the borders of the Arctic Sea, according to his "Second Voyage," page 333, as quoted by Squier.* "They point their arrows and spears with it, and work it up into personal ornaments, such as collars, ear-rings, and bracelets, which they wear on their wrists, arms, and legs. They have it in great abundance, and hold it in high estimation." Alexander Henry,

* "Smithsonian Contributions," vol. ii, p. 117. Bancroft ("Races of the Pacific Slope") mentions the mining of copper on Coppermine River, by existing tribes.

in his "Travels," page 195, states that the Indians obtained copper at Lake Superior, "which they made into bracelets, spoons, etc." De Soto found copper hatchets in possession of some of the tribes along the coast of the Gulf of Mexico, which they stated they obtained from a province called Chisca, far to the north. Claude Allouez, in 1666, visited Lake Superior, and states that "it happens frequently that pieces of native copper are found, weighing from ten to twenty pounds. I have seen several such pieces in the hands of savages; and, since they are very superstitious, they esteem them as divinities, or as presents given to them to promote their happiness, by the gods who dwell beneath the water. For this reason they preserve these pieces of copper wrapped up with their most precious articles. In some families they have been kept for more than fifty years; in others they have descended from time out of mind, being cherished as domestic gods. For some time there was seen near the shore a large rock of copper, with its top rising above the water, which gave an opportunity for those passing by to cut pieces from it; but when I passed that vicinity it had disappeared. I believe that the gales, which are frequent, like those of the sea, had covered it with sand. Our savages tried to persuade me that it was a divinity who had disappeared, but for what cause they were unwilling to tell" (Foster and Whitney's "Report on Lake Superior," Part I, page 7). Dablon, in his "Relation" for 1669–'70, states that "the savages did not agree as to the source of the copper. Some say that it is where the river [Ontonagon] begins, others that it is close to the lake, in the clay, and others at the forks and along the eastern branch of the river." Again, Dablon gives an account of its being reputed to occur on an island about forty or fifty leagues from the *Saut* toward the north shore, opposite a place called Missippicoatong (Michipicoten?). The savages related that the island was a floating island, sometimes near and at other times far off. These statements, with other particulars, make it very probable that the Indians of Lake Superior were familiar with the localities prior to their acquaintance with the French, and that the place here described can be no other than the even then celebrated mines of Isle Royal.

Jacques Cartier in 1535 spent the winter at or near Quebec, and learned several facts concerning copper that was in possession of the Indians, which he has given in his "Brief Recital." They made an effort to explain to him where the copper came from. They gave Cartier to understand that there were large quantities where they obtained it, situated on a bank of a river near a lake. One of the chiefs drew from a sack a piece of copper a foot long and gave to Champlain. "This was quite pure and very handsome." He said they had "gathered it in lumps, and having melted it spread it out in sheets, smoothing it with stones."* The Indians at Montreal and

* Champlain's "Voyage du Sieur de Champlain," Paris, 1613, p. 246, as quoted by Slafter.

Quebec in 1535 were familiar with the fact that *Saguenay* was a copper-bearing region. John Gilmary Shea, LL. D., says (Shea's "Charlevoix"): "The *Saguenay* of the St. Lawrence Indians was evidently the Lake Superior region, and possibly the ports accessible by the Mississippi. The river *Saguenay* was not so called from being in but from leading to *Saguenay*." Thus, at a distance of from eight hundred to one thousand miles from its origin, Cartier in 1535, and Champlain in 1610, encountered Indians who informed them of the manner of mining, and of manufacturing copper implements, Champlain stating that the copper was melted.

It is not presumed that this is a complete list of historic references to the use of copper and copper mining by the Indians, but it is amply sufficient to show that it is not necessary to invoke a strange race, prior to the Indian, to account for all the copper implements and the nuggets of copper that have been found in the mounds, as well as for those found on the surface of the ground throughout the Northwest.

The term *mound-builders* is distinctively applied to the race that constructed the remarkable earthworks of the valley of the Ohio, and of the interior of the United States in general, but it is true that in nearly all parts of the world the practice of mound-building has prevailed, sometimes among nations that come within historical epochs. Mounds are found among the Celts and the Scythians, in the Sandwich Islands and in New Zealand, in Japan and India, and throughout the central parts of the Eastern Continent, as well as in both Americas, from the country of the Esquimaux to Chili and Fuegia. The earliest of human records refer distinctly to this method of honoring the dead. The heroic age of Greece, as sung by Homer, abounded with ceremonies and curious details relating to the *tumulus* erected over the bones of the slain hero. The burial of Patroclus, as related in the twenty-third book of the "Iliad," is an illustration of the practice of mound-building by the ancient Greeks:

> "The sacred relics to the tent they bore,
> The urn a veil of linen covered o'er.
> That done, they bid the sepulchre aspire,
> And cast the deep foundations round the pyre;
> High in the midst they heap the swelling bed
> Of rising earth, memorial of the dead."

At the burial of Hector, the Trojans erect a pile of large stones over the urn containing his remains, and upon that pile up the tumulus. When Æneas buried the pilot of his fleet, Misenus, he

> ". . . piously heaped a mighty mound sepulchral."

Artachæas, superintendent of the canal at Athos, was honored by Xerxes with a memorial mound which still remains, in remembrance of the skill of that engineer, and an evidence of the custom of the

Persians. The Scythian kings are entombed in *tumuli* along the banks of the Dnieper. Orestes, bewailing his father, Agamemnon, says:

> "If but some Lycian spear 'neath Ilium's walls
> Had lowly laid thee,
> A mighty name in the Atridan halls
> Thou wouldst have made thee.
> Then hadst thou pitched thy fortunes like a star,
> To son and daughter shining from afar,
> Beyond the wide-waved sea the *high-heaped mound*
> Had told for ever
> Thy feats of battle, and with glory crowned
> Thy high endeavor."

In Asia Minor the tomb of Alyattes, the Lydian king, has a circumference of nearly a mile, requiring ten minutes to ride round its base. In the same neighborhood, near the lake Gygæa, are numerous other circular mounds.

The same practice was continued into the later days of Grecian history. Alexander raised a mound over Demaratus, which, Plutarch says, was "eighty cubits high and of vast circumference." The *tumulus* erected on the plain of Marathon, in commemoration of the one hundred and ninety-two Athenians who fell in the battle, is near the sea, and is to be seen by all travelers. It is about one hundred feet in circumference, and about twenty-five feet high. Finally, coming within the scope of modern history, the construction, at the order of the English Government, of a mound of earth on the plains of Waterloo, attests the tenacity of that sentiment of veneration for the dead who die in the service of their country, and the persistence of a practice, which seems to be common to all mankind and to have survived from prehistoric times, of resorting to the mound of earth, as being at once the easiest made and the most enduring monument in memory of the departed.

The practice of mound-building not being distinctive of any race, tribe, or epoch of the human family, it may be considered not at all unlikely that the aboriginal tribes of America, perhaps without exception, had their ceremonies and habits of burial, if not other rites of a sacred character, in one way and another associated with the erection of mounds of earth. Indeed, it would be a remarkable exception if the native Americans did not erect mounds. They possessed the land without molestation prior to the discovery of Columbus. They had the necessary elements of perpetuity and stability, at least so far as these can be predicated of savage tribes. They cultivated the soil and conducted a considerable trade with their neighbors. They exhibited all other characteristics common to mankind in an uncivilized state. The denial of their resort to mound-building, for the same purposes as other tribes in similar circumstances, carries with it the necessity to account for such an anomalous exception.

It is often stated that the Indian, when interrogated concerning the mounds and earthworks of the country, shakes his head in ignorance, affirming that he knows not their origin. This fact is carried further than it should be when it is invoked to prove the non-Indian origin of these mounds. Admitting, with some reservation, that the Indian at present knows nothing of the origin of the mounds, still it may be true that his immediate ancestors were familiar with the facts of their erection. The Indian has been driven from the home where he was born, and where his ancestral traditions and customs have centered and exhibited their unconstrained development, and has been a fugitive for several generations, from the cupidity and the bayonet of the white man. When it is remembered that the erection of a mound, such as are seen all over the Northwest, was not the act of a day, nor of a year, but of many years, and perhaps generations, it is easy enough to understand why the custom has become so nearly extinct. The Indian has become greatly modified by contact with the European. He has gradually been compelled to forsake many customs and abandon arts, which came into competition with the customs and the arts of the stronger race. The semi-nomadic life which he has been compelled to adopt has not been favorable to the erection of mounds, which requires the quiet of permanent and peaceful residence.

We are not, moreover, without testimony to the fact that the present Indian tribes did build mounds. Lewis and Clark mention the custom among the Omahas, saying that "one of their great chiefs was buried on a hill, and a mound twelve feet in diameter and six feet in height erected over him. Bertram states that the Choctaws covered the pyramid of coffins taken from the bone-house with earth, thus raising a conical hill or mound. Tomochichi pointed out to General Oglethorpe a large conical mound near Savannah, in which he said the Yamacraw chief was interred, who had, many years before, entertained a great white man with a red beard, who entered the Savannah River in a large vessel, and in his barge came up to the Yamacraw bluff. Featherstonhaugh, in his "Travels," speaks of the custom among the Osages, referring to a mound built over the body of a chief, called Jean Defoe by the French, who unexpectedly died while his warriors were absent on a hunting expedition. Upon their return they heaped a mound over his remains, enlarging it at intervals for a long period, until it reached its present height. Bradford says* that many of the *tumuli* formed of earth, and occasionally of stones, are of Indian origin. They are generally sepulchral mounds—either the general cemetery of a village or tribe, funeral monuments over the graves of illustrious chiefs, or upon a battle-field, commemorating the event and entombing the fallen, or the result of a custom, prevalent among some of the tribes, of collecting at stated intervals the bones

* "American Antiquities and Researches into the History of the Red Race," 1841, p. 17.

of the dead, and interring them in a common repository. A mound of the latter description was formerly situated on the low grounds of the Rivanna River, in Virginia, opposite the site of an old Indian village (Jefferson's "Notes on Virginia," pp. 100, 103). It was forty feet in diameter and twelve feet in height, of a spheroidal form, and surrounded by a trench, whence the earth employed in its erection had been excavated. The circumstances attending the custom alluded to were, the great number of skeletons, their confused position, their situation in distinct strata, exhibiting different stages of decomposition, and the appearance of bones of infants. A mound of similar character, and constructed in layers or strata at successive periods, existed near the south branch of the Shenandoah, in the same State. A *tumulus* of stones, in New York State, is said to have marked the grave of a distinguished warrior (McCauley's "History of New York," vol. ii, p. 239). "Beck's Gazetteer" (p. 308) states that "a mound of the largest dimensions has been thrown up, within a few years, in Illinois, over the remains of an eminent chief." The Natchez Indians, when expelled from Louisiana in 1728, erected a mound "of considerable size" near Natchitoches, as stated in the documents accompanying the President's message for 1806. C. C. Jones, referring * to plate xl of the "Brevis Narratio," says that "here we have a spirited representation of the ceremonies observed by the Florida Indians upon the occasion of the sepulture of their kings and priests. Located in the vicinity of the village appears a small conical mound, surmounted by the shell drinking-cup of the deceased, and surrounded by a row of arrows stuck in the ground. Gathered in a circle about this sepulchral *tumulus*, the bereaved members of the tribe, upon bended knees, are bewailing the death of him in whose honor this grave-mound had been heaped up." Jones also mentions an instance of a primary burial under a mound erected in honor of the dead, on the coast a few miles below Savannah, in which, along with an earthen pot, several arrow-heads, a stone celt, and bones of a human skeleton, was found in immediate association *a portion of an old-fashioned sword.* This *tumulus*, thus proved to have been erected since the advent of the Europeans, was seven feet high and about twenty feet in diameter at the base. Of the sword, the parts preserved were the oak handle, most of the guard, and about seven inches of the blade. The rest had perished from rust. The Mandans, according to Catlin ("North American Indians," vol. i, p. 90), constructed mounds in commemoration of their dead, and the same is said of the Arickarees by Professor Lewis H. Morgan (twenty-first report of the New York State Cabinet). The mounds at Lanesboro, in the State of Minnesota, are said by the old Winnebago chief Winneshiek † to have been erected by the Sioux, in commemoration

* "Antiquities of the Southern Indians."

† This old chief is still living, near Trempeleau, Wisconsin, and is said to be about one hundred years old.

of a great victory won there over the Winnebagoes many generations ago. The same old chief, when shown a clay pipe taken from the Lanesboro mounds, said it was like those made by the Sioux, and, pointing to an earthen spittoon for illustration, said the Sioux made many like it. In the "Proceedings of the American Association for the Advancement of Science," for 1875, Dr. Sternberg, of the United States Army, critically analyzes the contents of certain mounds near Pensacola, Florida, and concludes that they were built by different but contemporaneous tribes of Indians, one being probably the Natchez. In these mounds were found pottery, red hematite for pigment, flint weapons, and shell ornaments in the shape of beads and perforated disks, in conjunction with *blue-glass beads and fragments of iron.* The latter show that these mounds were still used, or in process of erection, later than the advent of Europeans.

Mr. E. G. Squier, in the second volume of the "Smithsonian Contributions to Knowledge," has described in detail many mounds and earthworks of western and central New York, remarking that they extend down the Susquehanna as far as the valley of the Wyoming, northward into Canada, along the upper tributaries of the Ohio, and westward along the shores of Lakes Erie and Ontario. These mounds and earthworks are said generally to be smaller than those in the Ohio Valley. They were found to contain ornamented pottery, pipes of clay regularly and often fancifully molded, or bearing the forms of animals, stone axes and hammers, stone disks and implements which the author remarks are almost identical in shape and material with some described by him from the mounds of the Ohio Valley, and spear-points and bodkins of bone. In connection with these are described articles of European manufacture, such as cast copper and iron axes, and kettles of copper, iron, and brass. Although Mr. Squier had previously expressed the opinion that the earthworks of western New York were of like nature and origin with those of the Ohio Valley, when confronted with the fact of articles of European manufacture commingled with aboriginal, discovered by his own investigations, he was forced to assign the New York mounds to the Iroquois. It seems not unreasonable to assume that the New York series of mounds will be found undistinguishable from those of northern Ohio and eastern Michigan, which have unquestioningly been regarded as of the same age as those of the Ohio Valley, as well as synchronous with those of Wisconsin, which, while possessing all the essential characters of the Ohio Valley mounds, have been assigned as unhesitatingly to the existing races of Indians by the late J. A. Lapham, of Milwaukee.

It hence seems demonstrable, as well as admitted by some of the best American ethnologists, that the existing Indian races formerly carried on extensively and methodically the practice of mound-building. The mounds of sepulture are often referred to by historians and

travelers. They were built by slow accretions. Not to mention the veneration which impelled the untutored savage to cast a handful of earth on a mound every time that he passed it, in testimony of his remembrance of the departed, it may be well to refer to what has been known as the *feast of the dead*. This is asserted to have been common to many tribes, although conducted with some variation of details. Gathering the bones of the dead from their temporary resting-places, the tribe assembled at a chosen spot, and with solemn ceremonies performed the last rites of sepulture. Sometimes they were placed in coffins separately, and buried within a pit over which was erected a mound of earth, and sometimes they were arranged serially, and simply buried under a mound. More frequently the bones were burned, the cremation being accompanied with lamentation and followed by feasting. The ashes and the unconsumed fragments were then covered with earth. For many generations this *feast of the dead*, which occurred sometimes every eight years, or every ten, or when the accumulated bones made it necessary, was doubtless performed on the same spot; and in course of time a mound of considerable dimension was the result, which, while containing human bones, or fragments of them, and much evidence of fire in the form of ashes and charcoal, and reddened stones, yet discloses, on exhumation, no perfect skeletons.

As further testimony to the erection of mounds by the present Indians, the statements and opinions of a few who have investigated the subject, or have dwelt long with them, may be referred to.

Mr. Jones, in his review of the "Antiquities of the Southern Indians," remarks: "During the progress of this investigation it will be perceived that mound-building, which seems to have fallen into disuse prior to the dawn of the historic period, was entirely abandoned very shortly after intercourse was established between Europeans and the red-men." Again, in summing up the evidence, Mr. Jones says, in conclusion, "In a word, we do not concur in the opinion, so often expressed, that the mound-builders were a race distinct from and superior in art, government, and religion, to the Southern Indians of the fifteenth and sixteenth centuries." Bradford, in "American Antiquities and Researches," affirms that "from very respectable authority it appears that many tribes still continue to this day to raise a *tumulus* over the grave, the magnitude of which is proportioned to the rank and celebrity of the deceased."

From the foregoing it appears that every known trait of the mound-builder was possessed also by the Indian at the time of the discovery of America. It hence becomes unnecessary to appeal to any other agency than the Indian. It is poor philosophy and poor science that resorts to hypothetical causes when those already known are sufficient to produce the known effects. The Indian is a known adequate cause. The assignment of the mounds to any other dynasty was born

of that common reverence for the past, and for the unexplainable, which not only unconsciously augments the actual, but revolts at the reduction of these works to the level of the existing red-man.

WRITING PHYSIOLOGICALLY CONSIDERED.

By CARL VOGT.

MODERN investigations have shown us that certain parts of the brain, situated in the region of the temples, have a predominant share in the formation of articulate language; or, to express it in a short phrase, that the majority of men speak by means of the third frontal circumvolution of the left cerebral hemisphere. All who have occupied themselves a little with physiology know also that the nervous fibers cross each other in the brain, so that the movements of the left arm are commanded by the right hemisphere, while those of the right arm depend on the left hemisphere. Rushes of blood, extravasations, and apoplexies are unfortunately more frequent on the left side than on the right side of the brain: attacks of the left hemisphere are consequently followed by paralysis of the right limbs, and aphasia, or an impossibility to speak; but injuries to the right hemisphere, while they paralyze the left limbs, generally leave language untouched.

Does this center exist for writing as well as for language? Inasmuch as we are in the habit of writing with the right hand, it is evident that the movements necessary for the action of writing must be paralyzed by an affection of the left hemisphere. But we may learn to write with the left hand. The question, we see, becomes general; it extends to the general movements in writing, and is concentrated at last in a single point: are there facts which force us to admit a particular cerebral center, on which the movements in writing depend? In other words, does the manner in which we write depend upon a physiological necessity—determined by the structure of the brain? All peoples write with the right hand. It is of little importance whether this preponderance of the right is founded on a particular structure, or whether it is in great part the result of education and habit; man, writing with the right hand, writes therefore under the direction of the left cerebral hemisphere.

If this is a general fact, and I know of no exception to it, we may ask how it happens that the arrangement of the letters and the lines is so different among different peoples. The peoples of Eastern Asia, as a rule, arrange their letters from above down, and the lines from right to left; the Shemites and the Europeans put the lines one below another, but the Shemites arrange their letters from right to left, while the Aryans arrange theirs from left to right. The Shemites have centripetal writing, the Aryans have centrifugal writing.

The subordination of these three so different directions of writing to a single physiological principle is possible only in case we can show that there is only one normal direction in writing, and that the deviations from this normal direction are due to powerful causes and influences, which have prevailed over the direction primarily imposed by the structure of the brain.

It is necessary, while we are occupied with this question, to distinguish between the order of the lines and the letters and the formation of the letters themselves. The two things are in a certain degree independent one of the other. The individuality of the writer is manifested in the form, in the proportions of the letters, while the manner in which the lines and the letters are arranged one after the other displays no character of individuality.

A complete analysis of all the external influences that can have acted on the manner of writing is necessary to decide whether there exists only a single order of letters and lines imposed by nature, or whether the diversity which we see to-day is produced solely by external causes.

But the solution of this question, whatever it may be, will not suffice to furnish a detailed analysis of the cerebral functions that are put in action by writing. The formation of a letter by the hand that writes supposes necessarily that, by the movements of the fingers and the hand on one side and the visual impression of the eyes on the other, a conception of the figure produced is formed in the brain, which is retained for a certain time by the memory. The time required for the formation of the conception and the transmission from the brain of the will to produce the action is shortened by frequent exercise till the act comes to appear nearly unconscious. The more frequently a man writes, the more also will the figurative images produced by writing be fixed in his brain. But as his impressions and images are transmitted to his brain only by the muscular sensation of the single right hand—with the coöperation of the eyes, indeed—we have a right to expect that experiments and observations made on certain cerebral parts of paralytic patients will cast some light on the manner in which these figurative and largely unilateral images of the writing are formed and preserved in the brain.

For the present, we will occupy ourselves with the question, How did the ancients, how do the moderns, write? What were and what are the materials that they employ? Can we discover any connection between purely external causes and the manner of arrangement of the letters and lines?

So far as we know, representation by images has been the point of departure for all writing. Three primitive methods of writing were developed in the Eastern Hemisphere from the initial imagery: that of the East of Asia, or the Chino-Japanese method; that of the West of Asia, or the cuneiform; and the Egyptian, or hieroglyphic writing.

From the last were developed, step by step, the hieratic writing and the demotic alphabet, or current hand. The arrangement of the hieroglyphics was determined by no rule, but was dependent only on the form and size of the space in which the inscription was to be written.

It is absolutely indifferent to us whether we know what part the Egyptian demotic or the cuneiform writing has taken in the formation of existing alphabets. It is enough to know that we have three entirely independent forms of writing: the Chino-Japanese, which arranges the letters from the top down, and the lines from right to left, or centripetally; the Shemitic, which arranges the letters centripetally from right to left, and the lines one below the other; and what we may call the Aryan, which arranges the lines in the same manner, while it places the letters centrifugally, from left to right.

The last two styles may have been formed through a mingling of the demotic and cuneiform methods. Their common point of departure is in any case to be found in the hieroglyphics, and it is doubtless to this origin that we should attribute the absolute want of a fixed rule in the order of the letters and the lines in the most ancient specimens. Mr. J. J. Leslie, in his lectures on the origin and destination of man, speaks especially of the complete indifference of the ancient writers in regard to the placing of their letters. Many of the old Greek inscriptions were written alternately from right to left and from left to right, turning the direction as one turns a plow in the field, and this style was called "boustrophedon" (*turning like oxen*). The Egyptians often wrote in the same manner, and M. Stern says that the hieroglyphic inscriptions might, according to the nature of the characters used, run from the top down, from left to right, or from right to left —the latter direction, as in Shemitic writing, being the most common.

We conclude, generally, from these facts, that the arrangement of the images which were transformed successively into phonetic signs and letters had no rule as long as those images, signs, or letters, were engraved or painted on an immovable material, as stones, columns, or architectural monuments. The arrangement was governed by the character and shape of the material; it was horizontal on a cornice, vertical on a post, spiral on a column, according to the convenience or fancy of the writer. There is no place here for a fixed rule based on physiological necessity.

It was only when the man ceased to move before an immovable material, but when, on the other hand, the material (plates, tablets, paper, etc.) became movable before the man having a fixed position, that the normal directions as we now observe and distinguish them were established.

Do physiological reasons exist for the present methods of writing? Let us examine, with regard to this point, all the exterior conditions under which writing is done, beginning with the Chino-Japanese system. The people who employ this system do not write; they paint,

using a brush which is manipulated slowly and makes a thick stroke, and follow the order of arrangement of their mural pictures. Their temples are made of wood, and it is the posts that are ornamented, naturally from the top down. This direction is also most convenient in all painting, since it corresponds with the natural movements of the joints of the fingers.

The Shemitic peoples—the Bedouins of the desert, Arabs, Turks, and Mohammedan negroes—write squatting on the carpet, or sometimes standing; the right hand, holding the pen, hangs free from the arm over the paper, and the arm is not supported. The left hand, also free in the air, or supported on the raised left knee, holds the paper stiff or laid on a little board. The right hand stays unmoved in the same place; only the fingers are put in motion for the shaping of the letters; while the left hand continually pushes the paper from left to right, so that the letters assume an arrangement from right to left, or in a centripetal direction. Thus the Shemitic people in writing perform movements directly opposed to ours. We hold the paper still, and move the hand; they move the paper, and hold the right hand almost still, as the Koran orders them to do.

An alphabet of two hundred phonetic signs representing syllables was invented in 1832, by a negro of the Vei tribe, who had learned to read from a missionary. He taught his people to write with a reed-pen and ink; but, while he wrote from left to right, the whole nation to-day write from right to left. If, as some believe, our centrifugal system of writing from left to right is founded on physiological considerations, the Veis would not have departed from it after having been taught in it.

M. Erlenmeyer accounts for the direction of the Shemitic writing on the supposition of its having been originally centrifugal, by assuming that these people first wrote with the left hand, to which the direction of their writing would be centrifugal, and afterward changed the hand without changing the direction of the writing. This is exceedingly improbable, for the Shemitic races consider the left hand impure, and regard writing as a holy act, which they never could have thought of performing with an impure instrument. Another explanation must be sought.

Holy acts, with the Shemitic peoples, are performed looking toward the east; therefore, in writing, those people would turn their faces to the east. The light would then come from the south, and the scribe would write from the light toward the shadow, from the unrolled part of his paper toward the roll which he is continually unrolling with his left hand. If he wished to write from left to right, he would require to have the roll in his right hand, and, in that case, the thicker the roll the more it would cut off his light and be in his way. The centripetal direction, from right to left, was then for the primitive Shemitic peoples, and still is for the Orientals, the only natural direction; it is founded

on the posture which the writer takes, his position with reference to the light, and the material he uses, and has become dominant by custom. Persons who are acquainted with the Eastern languages tell me that it would be as impossible for them to write in one of them from left to right, as it seems to be to write in a Western language from right to left; yet most of these persons learned to write in German or French before studying Hebrew writing. The direction in which we write, from left to right, is the most modern of all. It is common to all the Aryans, but was probably not adopted till after the emigration from the primitive countries. In the face of the facts we have mentioned, we need not ask why the Shemites write from right to left; but we should rather reverse the proposition, and ask why the Aryans abandoned the more ancient Shemitic direction, of which they doubtless had some knowledge. Whence did they get the centrifugal direction, from left to right? Difference in material does not account for the divergence; no more does difference in position, for the ancients were not acquainted with our table and desk. And even now, all French youth in the higher institutions write on a tablet supported on their knees, which is held by the left hand while the right hand holds the pencil, precisely as the Oriental writes, except that the paper is held still while the right hand moves—the converse of the Shemitic manipulation—and the direction of the writing is reversed. I have sought for information respecting the manner in which the ancient Aryans wrote in the absence of chairs and desks, without finding anything which could furnish an explanation of our mode of aligning the letters, so contrary to those of other peoples. The direction has become hereditary with us, transmitted from generation to generation, and our furniture, implements, and positions have become conformed to it. In setting our tables and adjusting our positions, we always seek to bring the light from the left, while the Shemite looks to the right for it. In both directions, centripetal and centrifugal, we write from the light toward the shade. If this is a general characteristic, and if, as we have sought to show, the primitive position of the writers depended on certain religious ideas, we may ask if there did not also exist particular religious reasons for the ancient Aryan method of writing.

My friend M. Charles Mayer, of Stuttgart, has remarked to me that the Aryans, in emigrating from their primitive home, followed the course of the sun, from the east toward the west. Their faces turned toward the setting sun, they had the noonday sun on the left. The left side, then, was the side of the light, of good luck; the right hand, the side of shadow and bad luck. The same signs had an opposite significance, accordingly as they appeared on one side or the other, in the inverse sense to that in which the Shemites regarded them. Have we not here a justification for the hypothesis that the Aryans turned their faces toward the west when they gave themselves to the holy operation of writing, and that, having the sun on their left, they

wrote like the Shemites, from the light toward the shadow, and consequently from left to right? If I insist so much on the primitive sanctity of the action of writing, it must not be forgotten that a close connection exists, even in our day, between the great religious domains and the method of writing. Buddhism, with all the Oriental religions of Asia which have preceded or followed it, writes from the top down; Islamism, the real continuation of Shemitism, writes from right to left; and Christianity, the emigrant product of Shemitism, which has left its father to settle among the Aryans, is scattering writing from left to right over nearly the whole world. Each of the three great religious groups has, then, a direction of writing peculiar to it.

I am far from meaning to pretend that all the questions are solved, and that the series of proofs I have presented is continuous. If I publish the results so far obtained, it is to excite interest and awaken discussion. But it seems to me to follow, from what I have said, that the direction of writing, the order of the letters and the lines, are in no way the forced consequence of a physiological cause, of a particular structure of the brain. I believe that I have proved, on the other hand, that the order of writing was primarily dictated by exterior causes, which, in many cases, may have wholly disappeared, but the result of which has been retained by habit and hereditary transmission. Our organization permits us to write with equal facility from the top down, from right to left, from left to right; no physiological condition has compelled us to choose a particular direction. If we select a determined order and drop the others, it is because we have learned to do so from our ancestors; and this order has been imposed on our ancestors in consequence of different external circumstances.

MODERN BASIS OF LIFE INSURANCE.

By THEODORE WEHLE.

WITH the year 1839 a new phase is reached in the first effort to tabulate the actual experience of insurance companies. Heretofore the average life of towns had furnished the data for mortality tables; now a table was to be deduced from observations of insured lives. Seventeen leading offices appointed a committee, to whom copies of their records were to be intrusted, which, owing to jealousies, were not as perfect as desirable. In 1843, after years of labor, a table was published, now known as "Actuaries' Experience Table No. 1." It was based on 18,282 policies, of which 7,372 had been discontinued, 4,786 had terminated by death, and 6,124 were still in force. The average duration of the policies under observation was eight and a half years.

In 1869 a table taking a far wider range was compiled, known as "Actuaries' Experience Table No. 2." It comprised the experience of twenty English and Scotch offices, all over twenty years old. It treats of 146,847 lives, which on an average had been under observation for ten years, and records 23,856 deaths. This table was not graduated until recently, and is only beginning to come into use.

About the same time Mr. Sheppard Homans published the "American Experience Table," based principally on twenty-six years' experience of the Mutual Life Insurance Company of New York. For the very young and old ages where the data were insufficient, he also made use of other American and English statistics. This table has been adopted as the official standard for New York and many other States.

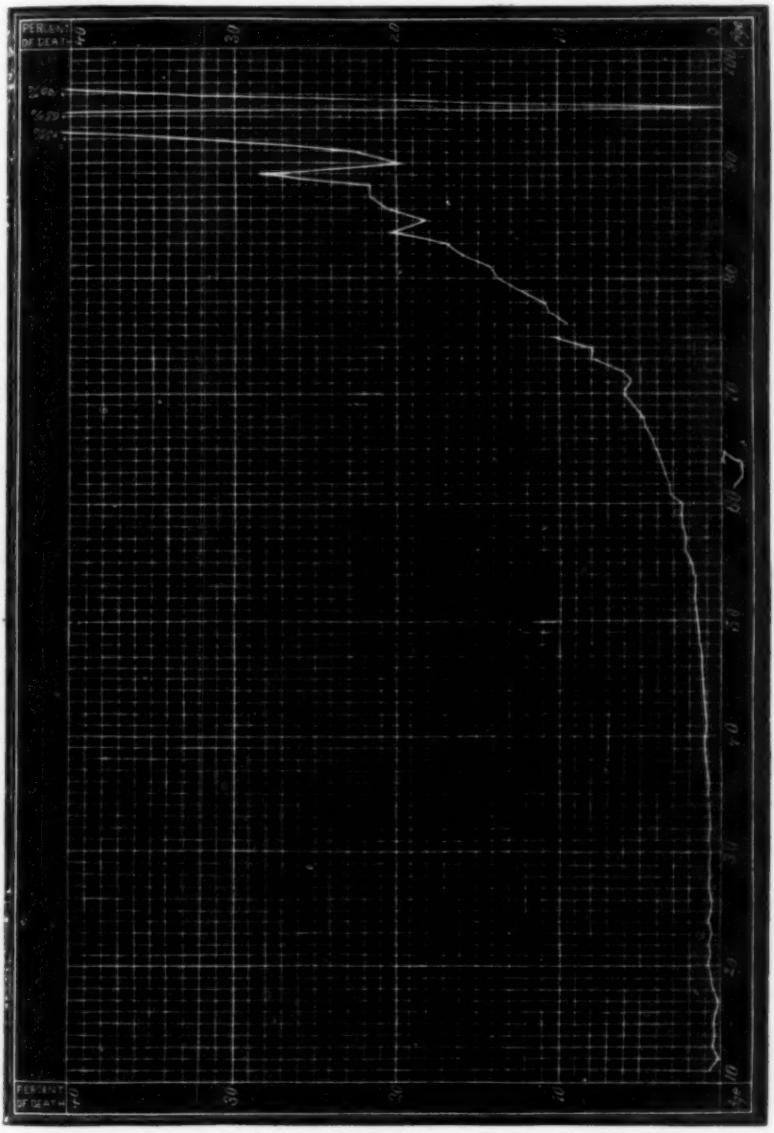
The exact numbers and other details that served as a foundation for all these mortality tables have been given rather fully, at the risk of wearying the reader. The object has been to indicate the difficulties of obtaining them in a reliable and sufficient form, and on such a scale as to furnish trustworthy averages.

A little reflection will show that large numbers must be observed for a long term of years, to have deaths occur for every single year of life, and in the proper proportion for each age. Take as an illustration the Carlisle table based upon 1,840 deaths in eight years, which would average 230 deaths per year. According to the present mortality of England, about forty per cent. of the deaths of the whole population occur among children under five years old, forty per cent. between the ages of five and sixty-five, and twenty-per cent. in old age, between sixty-five and one hundred years. Apply these percentages to the 230 deaths at Carlisle, and they would give 92 persons dying under five years old, 92 between five and sixty-five years, and 46 between sixty-five and one hundred years of age. For the last thirty-five years of life only 46 deaths would be likely to take place, because, while the percentage of mortality is high, the number living at those ages is very small. But, when 46 deaths are distributed among thirty-five years of life, it is apparent that they are not likely to prove regularly divided among them. At some ages, and they may be the very highest, no deaths at all may occur. We know, however, that it is not in the course of nature that in any one year of life no human being should die, and properly ascribe it to the small number and the short space of time observed. Here the mathematician steps in and determines, from the insufficient data gathered, what the probable percentage of deaths would be for every year of life, in large communities living under similar conditions.

In illustration of what has been said, and as both interesting and instructive, the actual percentage of deaths comprised under the "Ungraduated Actuaries' Experience Table No. 2" is herewith given in graphic representation:

The table shows the remarkable fact that, out of so large a number

as 23,800 deaths, not a single individual died at ages eleven, sixteen, and ninety-four. This is due to the insufficient number of persons insured under twenty years, and the very small number living above



ninety years of age. The other most apparent fluctuations are a fall at age eighty-nine and a sudden rise at ages ninety-two and ninety-three. Here, again, for the same reasons, a very few deaths above or below the average cause large differences in the percentage. But

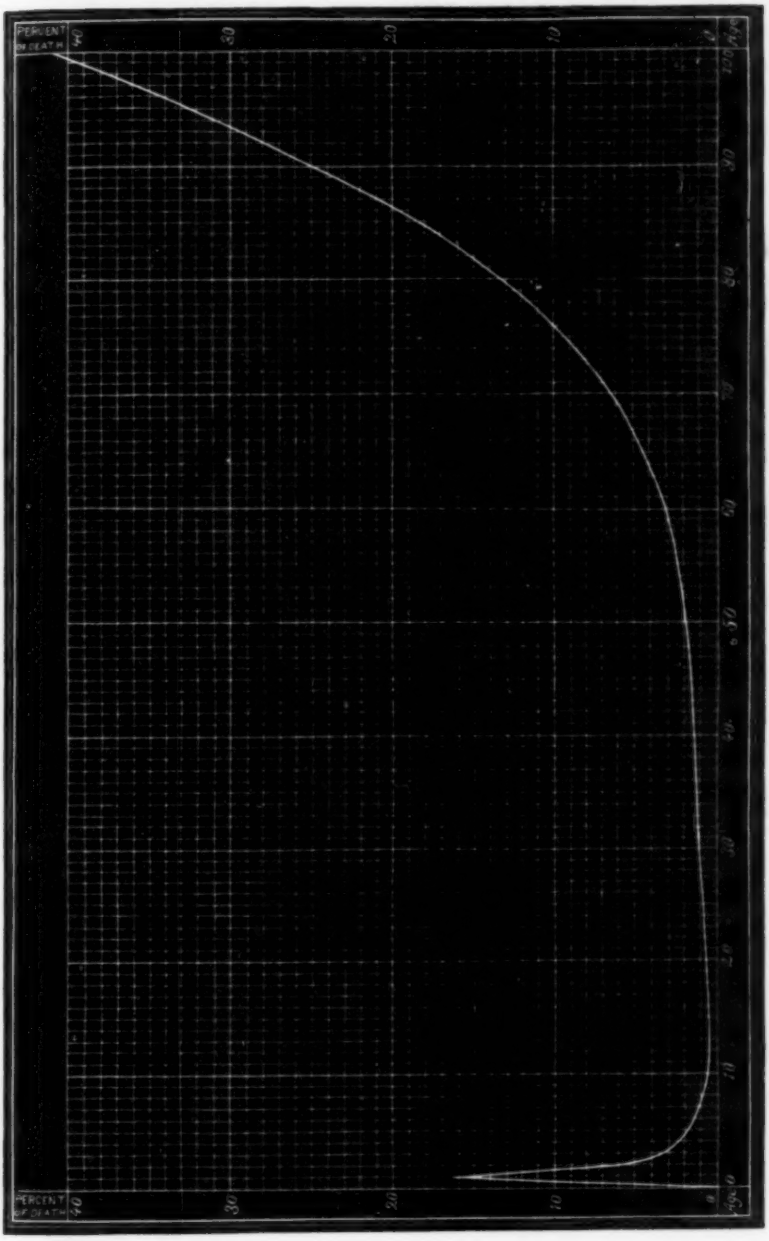
more or less deviation was experienced for almost every year of life, although the small scale to which the representation is necessarily confined does not clearly indicate it. The most superficial examination, however, must convince us that we are not dealing with accidents, but with a clearly pronounced tendency in the rate of mortality, disturbed only by minor causes.

Leaving for the time life-insurance experience, for the wider field of vital statistics generally, we have to note a most important step, in the introduction of the decennial census in England in 1801, and the adoption of a system of registering deaths, births, and marriages, begun in 1836.

The data were thus collected for constructing a mortality table, embracing the whole population of England. This task was undertaken by the Assistant Registrar-General, Dr. Farr, on the census of 1841, and is known as "English Life Table No. 1." It is based on about 16,000,000 lives and 344,000 deaths. In 1863 he published a second table called "English Life Table No. 2," using the data of the census of 1841 and extending the deaths to three years previous to and three years subsequent to 1841. This period of seven years (1838 to 1844) furnished 2,436,648 deaths. Finally, in 1864, "English Life Table No. 3" was given to the public in the form of a distinct work. It was deduced from the two censuses of 1841 and 1851, and other records for the seventeen years from 1838 to 1854, embracing some 50,000,000 persons living and 6,470,000 deaths. Here, at length, we have a life-table on the largest scale, comprising the population of a whole country from birth upward. A graphic representation of the same is herewith presented, as that conveys a clearer picture to the mind than the reading of the numbers of the living and dying for every age.

On comparing Life Table No. 3 from ten years upward with the "Ungraduated Actuaries' Experience Table No. 2," it will be observed that the *direction* of the curve is very similar in both; but, while the one is absolutely smooth and even, the other is disturbed by the more or less violent deviations already referred to. The process of removing these unevennesses in the line, actuaries call graduating or adjusting. It is a very delicate and most important problem, for it involves no less than the effort to determine the law of mortality, freed from the accidental influences which experience has recorded. The outline of this law is, indeed, clearly defined, and can be traced in every table—a high rate of mortality in the first year of life, decreasing until the minimum is reached somewhere near the age of puberty, then rising very gradually, until with old age a very rapid increase takes place. But, while these general traits are well established, the details are subject to continual deviations.

We must assume that there is a fundamental law of life accompanying the organization of the human being, but that it is fre-



ENGLISH LIFE TABLE No. 3.

quently traversed by many artificial and accidental influences. To determine the normal and eliminate the accidental conditions is the aim of theoretical inquiry. On the other hand, it may be urged that there is no normal standard of life nor of its surroundings, and that

length of life is merely an expression of the sum total of social influences upon the organism. A community may be divided into ever so many groups, each of which will have its peculiarity, and the summary of all these units will give as resultant the average of life. Every graduated mortality table may, therefore, be considered only an approximate expression of the death-rate under the conditions and at the time of observation.

We may now follow "English Life Table No. 3" more in detail. It gives a separate record of both male and female life, and we may examine the mortality of males first.

The notation adopted refers to the percentage of death in the current year; 0 meaning from birth to end of first year, 1 from beginning to end of second year of life, and so on:

Age.	Percentage of deaths.	Age.	Percentage of deaths.	Age.	Percentage of deaths.	Age.	Percentage of deaths.
0	16·36	15	·52	40	1·30	70	6·73
1	6·40	20	·83	45	1·54	80	14·18
5	1·36	25	·92	50	1·88	90	26·41
10	·56	30	1·00	55	2·45	95	34·21
13	·47	35	1·13	60	3·25	100	41·78

The table ends with age 107.

Taking birth as a starting-point, the mortality for the first 5 years of life is 27·64 per cent.
" " " " " " " 10 " " 31·02 "
" " " " " " " 20 " " 34·82 "
" " " " " " " 44½ " " 50·00 "

The rate of mortality of age 5 is again reached at about age..... 41
" " " 1 " " " " 70
" " " 0 " " " " 82

About 1 in 4½ of all children born will reach age..... 70
" 1 " 10 " " " " " 78
" 1 " 100 " " " " " 90

Let us now compare male and female mortality. There are born 511,745 males to 488,255 females, being an excess of 23,490 males = 4·81 per cent.

During age 0, the deaths are 83,719 males to 65,774 females: leaving males in excess..... ..... 1·31 per cent.
At " 8.....the excess of males living is 1·00 "
" " 15..... " " " 1·18 "
" " 37..... " " " 2·08 "
" " 50..... " " " 93 "
" " 53..... .....the sexes are about even in number.
" " 70.....the excess of *females* living is 8·00 "
" " 80..... " " " 19·00 "
" " 90..... ..... " " " 41.00 "

End of table for male life is 107 years, for female life is 108 years.
Equation of " " 44½ " of " " 46½ "
Of males living at age 20, about 1 in 3 will reach 70 years, of females 1 in 2⅞.
" " " " " 1 " 8 " " 80 " " 1 " 6⅝.
" " " " " 1 " 70 " " 90 " " 1 " 49.

Thus it appears that, with the exception of the period from fifteen to thirty-seven, where the larger mortality can be easily explained on physiological grounds, females have a far better chance of life than males. This is particularly marked in the first year of life, and after fifty-three years of age.

Some of the results deduced from this table will no doubt surprise many. It is not commonly assumed that age thirteen is the healthiest in life, or that so large a proportion of infants will reach as high an age as is here indicated. Nor is it generally known that more boys are born than girls, and that the weaker sex has such decided advantages in life over the stronger. But, while nearly five per cent. more male than female infants are born, the very reverse appears in the whole population, there being about five per cent. more females living than males. Of course, these proportions refer to England only, and they vary in different countries, according to conditions and influences that the reader can readily picture to himself.

English Life Table No. 3 marks an epoch in statistical science, and the results obtained are valuable and sufficiently reliable for practical purposes, but much yet remains to be done to satisfy scientific inquiry. An annual census, which is strongly urged, would allow a closer and more frequent examination of facts, and reduce mathematical speculation to a minimum.

One question of grave importance can not yet be considered as definitively settled; it is whether the rate of mortality is steadily declining, and the duration of life is correspondingly extending. In a general way, and as compared with former centuries, there can be no doubt that a marked improvement is to be found. Take the population of England as an illustration:

It was estimated in	1651 at	5,450,000
" "	1751 at	6,400,000
Census of	1801 at	8,892,536
"	1851 at	17,927,609

This shows an increase of seventeen and a half per cent. for the century from 1651 to 1751, of thirty-nine per cent. for the fifty years to 1801, and of one hundred and one and a half per cent. for fifty years to 1851.

These rapid strides are not astonishing when we consider the epidemics, the internal strife, the famines, and insufficient means of communication, the disorderly and unsettled habits of former times, and compare them with the better hygiene, the greater comforts, and the generally refining influences of the present. But this increasing ratio of growth may be due either to a larger percentage of births, or to a smaller proportion of deaths, or to both causes combined. Statistics seem to indicate that both factors are even now contributing to this result. In 1841, out of 1,000 of the population, 15·4 were married dur-

ing the year, and in 1876 the number had gradually risen to 17 per 1,000. So that, in spite of large cities and the greater difficulty of supporting families, the growing tendency to settled and more regular habits is exhibited in the larger number of marriages. The result is an increasing number of births in proportion to the population. In 1841, 512,158 children were born, being 32·2 per 1,000, while in 1876 the number was 887,464, or 36·6 per 1,000, which is an increase of about twenty-five per cent. The deaths, on the other hand, remained nearly stationary, being 21·6 per 1,000 in 1841 to 21·9 in 1876. The ratio of deaths to births, therefore, stood as 1 to 1·49 in 1841, while in 1876 it was as 1 to 1·74.

The preponderance of young families, however, ought to make the death-rate very much higher, as the mortality at the young ages is very large. Since it remained nearly unchanged, while the marriages and births increased, it would indicate that the average duration of life was being extended. For special localities like large cities, it is well known that sanitary measures and other causes are producing constant improvement; but there are many counteracting conditions to be considered. With an improved system of registration and more frequent enumerations of the people, data will be obtained for computing and comparing life tables at shorter intervals, and there can be no doubt that, in spite of increasing difficulties, the beneficial influences of higher civilization will be found to tend to a steady prolongation of human life.

Recurring after this digression to the experience of life-insurance companies, we will compare English Life Table No. 3 from twenty years upward with the two tables most in use, the Actuaries' Experience Table No. 1 and the American Experience Table. The percentages are given, in preference to the number of living and dying for each period:

AGES.	ENGLISH LIFE NO 3.	ACTUARIES' EXPERIENCE NO. 1.	AMERICAN EXPERIENCE.
	Percentage of deaths.	Percentage of deaths.	Percentage of deaths.
20	·83	·73	·78
25	·92	·78	·81
30	1·00	·84	·84
35	1·13	·93	·89
40	1·30	1·04	·98
45	1 54	1 22	1·12
50	1·88	1·59	1·38
55	2 45	2·17	1·86
60	3·25	3·03	2 67
65	4 59	4·41	4·01
70	6·73	6·50	6·20
80	14·18	14·04	14·45
90	26·41	32·37	45·45
95	34·21	58·43	100·00
99	41·04	100·00	.....
107	100·00	.....	.....

While the two experience tables are very similar, and represent about the same social conditions, the well-to-do middle classes, in this country and in England, the American table has a peculiarity characteristic of life in the United States. At the younger ages, up to thirty years, the mortality is greater, while from thirty to seventy years it is somewhat less than in England. During this latter, the most active period of life, the strain upon the system is very great in this country, and the vital forces are used up to such an extent that after seventy years the death-rate rises rapidly. The table ends at ninety-five, while the English is carried to ninety-nine. It may also be mentioned here that female life has proved less favorable than male life to insurance companies, while it will be remembered that the very reverse has been observed in the community at large. The next point that will attract attention is, that the English life table, representing the average life of the whole population, does not range so much above the insurance tables as might be supposed. Insurance companies select only healthy individuals by medical examination, and almost exclusively from the better classes and occupations. Why, then, is the difference not greater? Some of the reasons can be readily given. First, there is a constant effort on the part of the public to foist impaired lives upon the insurers. No amount of care or precaution can detect all misrepresentation or trace every inducement to fraud and self-destruction, and, while it may amount to less than some assume, it undoubtedly reduces the standard of absolute health. Of far greater importance is the observation that the effect of selection nearly wears away in about five years. Taking a class of lives selected by medical examination, say at twenty-five years, it will show a reduced mortality during the first year; but after five years, at age thirty, very nearly the usual average is again reached. For, while the diseased are excluded from the selected class, a certain number of these sound lives will find their health to fail from year to year. Were those admitted at twenty-five years to be reëxamined at age thirty, so many sick and ailing would be among them that the advantages of selection would be found to have largely disappeared.

Registrar-General Farr estimates 27 out of 1,000 of the whole population, between the ages of twenty and sixty, to suffer from some kind of disease or other, be it hereditary, chronic, recurrent, or acute. Consumption, he thinks, though varied in duration, seems to average about two years. The higher the age, the greater the value of selection; and, the older the members of a life-insurance company become, the more do they approximate the health of the community at large.

Another factor that operates as a selection against the mortality experience is what is called lapses. A large number of policies are constantly allowed to terminate through the indifference of the insured, and for various other reasons. But, while the healthy often forfeit

their insurance upon slight provocation, there are few indeed, of those that think their health impaired, that will do so. The result is, that an undue proportion of the sickly will remain, and exert a deteriorating influence upon the average mortality.

Finally, it must not be forgotten that there is, after all, a considerable difference in the middle ages between the English life table and the insurance tables, particularly the American Experience Table. This latter, Mr. Homans states, has the effect of selection carefully eliminated, and therefore indicates a higher rate of mortality than the actual experience. As a matter of fact, all well-managed insurance companies, doing a sufficiently large business to furnish the basis for reliable averages, and having a constant accession of *new lives*, experience more or less gain over the tables in use.

Before dismissing this subject, one question of a general character yet remains to be answered, viz., how do, or may, epidemics affect the average rate of mortality?

As regards the possibilities of the future, it is strictly a problem for medical and sanitary science; but we may be allowed to draw some inferences from the past records of a well-ordered state.

In 1849 a cholera epidemic, of a very malignant type, prevailed in England, considerably increasing the mortality for that year.

The number of deaths for the five years from 1848 to 1852 were as follows:

1848	398,385
1849	440,883
1850	368,602
1851	395,396
1852	407,135
	2,010,401

It will be noticed that in 1849 the increase over the previous year was about 42,000, while in the following year, 1850, there was a falling off to 30,000 below the number of deaths in 1848. For the period of five years from 1848 to 1852 the annual average of 400,000 remained undisturbed. This would indicate that, when through a powerful influence an excessive death-rate prevails, a large proportion of the weak and sickly is carried off, so that by way of compensation the surviving, healthier population will for a time show a mortality below the average. It is also well known that such inflictions are largely confined to the dirtiest and most crowded quarters, and carry off principally the poor and improvident. As these classes do not insure their lives, the mortality experience of insurance companies is no more likely to be seriously affected by epidemics in the future than it has been in the past.

STATE EDUCATION: A NECESSITY.

By CHARLES S. BRYANT.

IN the September number of "The Popular Science Monthly," 1880, appeared an article, reprinted from the "Fortnightly Review," entitled "State Education: a Help or a Hindrance?" It was written by the Honorable Auberon Herbert, an English writer of more than ordinary ability. He opposes state education on principle; and, as much of his reasoning applies in this country as well as in England, it is desirable that his fallacies should be exposed in the same journal that has given them currency here. The writer has neither limited his remarks to the English system, nor confined himself to obnoxious methods of applying courses of study to the education of the young in England or elsewhere. Had he done either, a writer on this side the Atlantic might have hesitated to question the propriety of his convictions. But, embracing, as he seems to do, the whole field of organized state educational effort, he has opened a theme as broad as the foundations on which society rests.

Some of his conclusions present points on which eminent educators, both in England and in America, widely differ. A note at the bottom of the first page of his article may have some modifying effect upon his radical conclusions. This note is in the words following: "I ought to say that I have changed my opinions as regards the action of the state since 1870. I would not have made this change without the assistance of Mr. Herbert Spencer's writings."—("Popular Science Monthly," vol. xvii, p. 585.) Mr. Spencer, to whose writings our author refers, has written many able things on education, with which educators are well agreed; but he is not understood in this country to be wholly opposed to state education. And it may be suggested that the disciple may differ with his teacher, or that the teacher may himself be misunderstood in the application of his principles to particular conditions of the social status. The conditions of the state, also, must be continually advancing beyond the demands of earlier efforts, as society in its tastes and needs moves forward. State growth has no limit, and hence no rule can be laid down for the government of the future that does not embrace the possibility of new combinations. The Spencer of to-day may predict, but the Spencer of to-morrow may find the historic progress in conflict with his prediction. Man's needs in his social and civil relations, in his artificial progress, can not be determined with the precision of mathematical certainty, as we determine the movements of the planets.

The English Government, of which the writer of the article under consideration is an integral element, is rapidly changing its position on the question of state education. The question with his country

seems not now to be, whether state education shall be inaugurated, but rather what kind it shall have. The state must retain control of all the elements necessary to its life. The educational element the state can not intrust to any organism beyond its control. Sovereignty must control the education which is the life and soul of the state.

The discussion on Sir John Lubbock's bill in the British Parliament, of recent date, was in relation to the studies to be introduced into the curriculum, rather than the question of state interference. An extract from "Nature," an English print, will set this matter in its proper light:

"It is unnecessary," says the writer, "for us to go again into the merits of the question which has been so often and so thoroughly discussed in these pages, especially as the 'Times' has put it quite as forcibly as there is occasion of doing at present. It certainly seems sad, nationally, indeed, that a few more millions of those who will have the destinies of this country in their hands are likely to be launched into active life, with all their education to acquire, ere legislation steps in to give us the advantages which nearly every other civilized nation gives to its children. Every day we hear of the ignorance of the working-classes, every other month 'congresses' are held to devise means to remedy the consequences of this ignorance: ignorance of the laws of health; ignorance of household economy; ignorance of the implements and objects of labor; ignorance of the laws of labor and production; ignorance of the nature of the commonest objects with which they come into contact every day; ignorance of almost everything which it would be useful and naturally beneficial for them to know; an ignorance, alas! more or less shared by the 'curled darlings' of the nation. Yet every day's paper shows how keen is the industrial competition with other nations, and how in one department after another we are being outstripped by the results of better—i. e., more scientific—knowledge; the poor pittance of 'elementary knowledge' asked for in Sir John Lubbock's bill is refused by a minister* whose own education leaves much to be desired. This state of things can not long continue, and, with such advocates for the children as the 'Times' and Mr. Forster, we may hope that next time Sir John Lubbock brings forward his bill it will meet with a happier fate."—("Popular Science Monthly," vol. xiii, pp. 562, 563.)

The truth expressed in the above quotation, that England, holding one of the most advanced positions of the human race, is yet being outstripped in one industry and another, in one department after another, "by the results of better—i. e., more scientific—knowledge," can not fail, in the reflecting mind, to suggest another truth: that civil society is a constantly developing organism, the range of whose future specialties must remain unknown. Yet through all, in the line of its direction, it is evident that some power must control. This

* Lord George Hamilton.

power must be the sovereign will. The *Cloister* and the *Castle*, the *Church* and the *State*, at different stages have severally presented their peculiar claims to wield the scepter of education. And the *supreme control* is now, in England and in America, fast passing from the Church to the state. Is the growth in this direction sound and normal? The integral elements certainly have more freedom, the intellectual powers more activity, and the forces and laws of nature are made more thoroughly subservient to the wants of the whole. We can not, therefore, say that in this direction the movement is abnormal, or that a result of a disastrous character will arise. The state organism indeed seems, so far, the most efficient. And England, believing in its healthy growth, even in elementary knowledge, now makes a strong appeal, not to the Church but to the state (not in its unorganized elements, but in its sovereign capacity) for the education of *all her people*. Is the appeal unwise? Can the results be anything but beneficial?

It is safe to believe that as human society advances it develops step by step relations of a wider, better, and different character; transferring responsibilities once peculiar to the lower to the next higher relation. The child of the family in turn becomes the man of the tribe, and the member of the tribe becomes the citizen of the state or nation. In this forward movement the family may have had absolute control during the age of childhood. In the next stage parental government is modified, or terminated, and yields to the dominant claims of the tribe. In the still wider national relation, the tribal government, embracing whatever there may be of culture in war and peace, at once yields to the supreme demands of the state or nation.

The child passes in any organized society through all the grades in the related social state. In the same order also government passes on, until it rests in the control of sovereignty, *the state*. And the right of the state to the custody and control of the citizen is as complete as the right of the parent to the control of the infant child. These are only the natural laws belonging to the several relations in the growth of society in all artificial conditions, under all governments. State control, therefore, comes into rightful exercise of authority over the education of every human being entitled to the privileges and protection of government. The particular age at which state authority may rightfully interfere in this relation is a matter of state policy and sovereign discretion.

All arguments, therefore, of the writer against either the right or the policy of the state, in exercising control over the education of the subject, rest upon a theory quite erroneous, upon the superior right of the parent over the control of the entire education of the coming citizen of the higher organization.

Mr. Herbert asks the pertinent question, "Could education be supplied without official assistance?" This question he answers in the

affirmative. His answer might be correct if confined to *some kinds of education*. But he does not seem to consider that the education conducted without official or state assistance, permission or direction, may be entirely opposed to the best interests of the state, and, indeed, subversive to its organization, and thus fall short of *the kind* of education required for the very existence of the state. Had he asked the more vital question, "Could education, such as is required for the existence of the state, be certainly supplied without state direction or official assistance?" the writer would hardly have answered that "the kind of education required could well be supplied without state direction and state authority." And it would seem that the real question for England and America to answer is, Will voluntary, individual, or associated parental authority at all times sustain the education required by the state? And still further, Will the education furnished by voluntary effort be equal to the demands of the successive generations as they come and go? To provide this, some authority must interpose some organized system of supervision, as active and continuous as the life of the government, and as extensive as the demands of the generations passing through the required course.

State education, then, is not only not a hindrance, but a necessity. state aid, however, in education is of wide application. It may not be necessary for the state to pay for education out of the state treasury, and still it may necessary to regulate by law some system of uniform public instruction. It may be necessary for the state to allow local taxation for the education which, without law, they might demand in vain. It may be necessary for states to allow, by statute law, a graded system of education, culminating in a university course. If the child is required to be educated in some particular way, he certainly should have the legal right to demand the time to acquire it, and the course of study legally defined. If he is allowed a time to acquire the state education, he should be allowed the necessary instruction during the time. These are correlative relations.

On no individual or associated plan, of a voluntary character, can education be supplied to the entire people, such as the state can rely upon for its own existence. It would take generations to give it even a partial existence in the most favored communities in the most advanced governments. At no one period could the voluntary plan apply the requisite culture to the entire masses passing the age of school culture. And to this conclusion the honorable gentleman seems himself to have come when criticising the present English attempt to introduce a national system. He says: "No truly great thing grows like a mushroom. An intelligent value for education can only spread slow, like civilization itself. In our hurry to act, we have not seen how much life and movement is sacrificed to make place for an official system. Those who administer such systems wish to get the flower ready made without any process of growth."

The voluntary plan has been tried by England ever since the island came under one rule. And this mode of application was not only not interfered with, but actually encouraged by the state. Immunity from certain punishments was granted to the man who could read. Even this low species of education was rewarded by the state with the title of "*clerk*, though neither initiated in holy orders nor trimmed with the clerical tonsure."—(Blackstone's "Commentaries," vol. iv, p. 366.) And, after this long reign of voluntary effort, encouraged for centuries by the state, and supplemented by the coöperative principle, the nation is now driven to assume the duty, as it has ever had the right, to control the educational system demanded not only by the parentage but by the whole people. Private efforts, individual and associated labors, all personal benefactions, and various national foundations, have severally exerted the voluntary and in part the coercive methods of education, and, under the most effective operation of them all combined, the national illiteracy has not been diminished, but is rather increasing with the growth in population. How, then, can this system, or, properly, no system, be relied on? With it, can England apply to practical demands the education which the slow growth of the ages has made ready for her hand? It is less a question how to create, than how to apply the knowledge now ready for the hungering masses.

Mr. Herbert objects seriously to state education, because "forced payments taken from other classes place the workman under an obligation; that, in consequence, the upper and middle classes interfere in the education of his children; that under a practical system there is no place for his personal views."

Now, it is hard to see how a tax for the education of the children of the workman should be more likely to create a feeling of obligation toward the tax-payer than would necessarily exist in any other case of taxation for the support of government, standing on the same legal foundation as a tax for education. Why should the feeling of obligation oppress the *royal family*, to know that *royalty* is upheld by a forced levy upon the property of the lords and landholders of the realm? It is certainly not such a feeling of dependence as the *royal family* wishes to discard. Royalty can certainly endure the strain quite as long as the tax-payers desire to continue the relation. But the feeling of obligation does not, in fact, exist between the workmen of England and the class taxed for education, while in this country, from the nature of our political society, it is not only unknown, but an impossible thing.

Labor, in all departments, physical and intellectual, working as a unit, produces a reservoir of wealth. This reservoir of wealth is *leisure*, a fund common to all, in which all are interested to the extent of their wants, natural or artificial. In the production of this common capital, the *laborer*, in the first form of production, is an essen-

tial ingredient. Without him the reservoir would contain nothing. And every worker of the series required to swell this reservoir of wealth has an interest in the end to be attained, and in every contribution to that end. The workmen embrace nearly every member of the national family. The interdependence is complete; and the obligation felt is not the kind to be avoided, but ought to be agreeable, mutual, and brotherly. However, a little inquiry will satisfy any one that the laborer feels that the world owes him quite as much as he owes the world. This argument, drawn from dependence and obligation, has no application in the family or in the nation. Analogies in *nature* are everywhere at hand. If any part of its articulated order fails, the whole is affected:

> "In Nature's chain, whatever link you strike,
> Tenth or ten-thousandth, breaks the chain alike."

So with the related order of society rising from native savagery to its highest artificial conditions.

A tax for education, considered from another point of view, might be properly regarded as a police regulation; and governmental action, state or national, rigorously and systematically applying it to the reduction of ignorance, that worst foe to a free people, viewed as a vital step toward securing the public safety.

Uniformity.—But uniformity is objected to, by Mr. Herbert, as an evil in the English system; and, if so, it would be the same in any other country. Such a system, he believes, is not sufficiently elastic, and does not yield readily enough to improved methods of instruction. Teachers and pupils and trustees go alike into the groove of established routine, and there remain, to the injury of the mental growth of all, and thus become a positive hindrance to progress. "Changes," he says, if ever made by great exertions, "would be only spasmodic; they would not be the natural outcome of the system, and therefore could not last."

It can be replied to this objection, that *uniformity* is but the precursor of variety, and without intelligent uniformity there can be no sure foundation for progress. We, indeed, expect the greatest variety from the most perfect uniformity and regularity in the systems we are investigating. Were there no laws of uniform operation in nature, we should have no foundation for science, physical or psychological; and the most perfect uniformity is yet so prolific in variety that the fields of human investigation are infinite.

But we have only space for one practical illustration of this principle of uniformity. We have, in America, a system of schools, either permitted by license from the State, or required by State enactments, which is quite as uniform a system as exists in England, and perhaps far more so. And the uniformity of the American system of graded free schools, for the forty years of their operation, has not as yet

presented any of the special or general evils so much feared by the honorable gentleman, and which to him seem so threatening in the schools of England. In several of our American cities the system has matured, during a period of some thirty-odd years, from the kindergarten to the university. These schools have produced whatever results the organism of the graded system is calculated to accomplish. The pupils have passed from the lowest grade, in regular order, in large classes, under similar programmes, in a uniform course, supervised by boards of trustees, and taught by instructors rising in literary attainments from grade to grade through the entire series. When the higher grades are reached, the pupils take more and more *optional* studies, and less and less *required*. And, as the curriculum widens toward the end of the course, the linguistic and scientific studies yield more and more to the inclination of the parent or the pupil, until the post-graduates of the high-school, as well as of the university, severally fall into chosen specialties, as their tastes and preparation may dictate. The result is all that could be desired. So independent and so varied are the subjects of this uniform, organized system of required and optional studies, and so thorough is the knowledge imparted in the selected fields embraced in its curriculum, that from one city its fame has passed from the Western to the Eastern Hemisphere, and in several important lines of skilled industries and art-culture received the award of superiority at the late Paris Exposition over the schools of the civilized world!

At the expense of a little brevity, let me here make a short quotation from a report of Superintendent Peaslee, of the Cincinnati schools, under date of 1880. He says: "I desire to call the attention of the board to the statement of the National Educational Association at Washington, in February last, by Hon. J. D. Philbrick, U. S. Commissioner to the Paris Exposition, and former Superintendent of the Public Schools of Boston. In speaking of the different school exhibits at Paris, Mr. Philbrick said, 'No other exhibits of scholars' work equal to that of Cincinnati was ever made in the known world.' It will be remembered that Mr. Philbrick was also United States Commissioner of Education at Vienna, in 1872, and that he was connected with the educational exhibit of the Centennial Exhibition at Philadelphia. 'In this connection,' he says, 'it gives me great pleasure to report that I have received, through the United States Commissioner, General R. C. McCormick, a gold-medal diploma and a silver-medal diploma, awarded to the public schools of Cincinnati, by the international jury at the Universal Exposition of 1878 held at Paris. I have had the gratification, also, of receiving from the Royal Industrial Museum at Turin a diploma of membership, as a token of their appreciation of the work of our school exhibit at Paris. As stated in a previous report, Cincinnati enjoys the most complete system of public-school education of any city in the world; for the pupils

of both sexes have not only open to them the advantages of the district, intermediate, and high schools, but possess the privilege of attending, free of charge, the University of Cincinnati. The course of instruction in their long-extended curriculum is of a very high character. From school to school the student passes, till he goes out into the world from the university with the broad teaching which will make him hold his own proudly in the stirring times in which we live."

In what this school is, as an organic element, preparing in American cities, we see in miniature the still wider organization growing up in the several States, preparatory to the completed national organization of the ideal AMERICAN SYSTEM OF GRADED FREE SCHOOLS. The cities, in the American State school system, under State law, by means of local levies, limited to the property of the city or district, with scarcely an exception, have built up this class of schools. The common school, with its corps of teachers, is followed by the high-school, with higher instructors and added supervision, and this again by the university, either for the city or the State, with a still higher order of instruction and supervision; and the organism is complete, each element in the series working apart but in harmony with the whole.

But finally we come to the religious question, which the ingenious objector to state schools has arrayed in its full force. Both in England and in America this question continues, to some extent, to be a disturbing element in the school problem. Mr. Herbert is not entirely free from the mist which this element creates in all sectarian atmospheres. He gives expression to his convictions in the following explicit language:

"I can not escape a few words on the much-vexed religious question. Under our present system the Nonconformists are putting a grievous strain upon their own principles. Whoever fairly faces the question must admit that the same set of arguments which condemns a national religion also condemns a national system of education. It is hard to pronounce sentence on the one and absolve the other. Does a national Church compel some to support a system to which they are opposed? So does a national system of education. Does the one exalt the principle of majorities over the individual conscience? So does the other. Does a national Church imply a distrust of the people, of their willingness to make sacrifices, of their capacity to manage their own affairs? So does a national system of education. Does the one chill and repress the higher meanings and purposes of formalism? So does the other."

The contrast between a national Church and a national system of education is quite clear to all persons, although there are several points of resemblance in their application. The two curricula are different in all those peculiar specialties in which each has its appropriate

sphere. One relates to temporal and the other to spiritual matters; and hence one embraces the great truth that the citizen should "render unto Cæsar the things that are Cæsar's"; the other, that he should render "unto God the things that are God's." The organisms that administer these curricula must necessarily differ. The comprehensive specialty of the Church is *faith* in a revealed religion. This, according to each sectarian creed, must be taught by the Church. The distinguishing specialty of the state is *law*, and obedience to this arbiter is the foundation on which the "life, liberty, and the pursuit of happiness" are guaranteed to the citizen, and must be taught by secular schools, either permitted directly or aided by the state. These organisms have each a special work. And while the state could teach religion as well as the Church could make and enforce laws regulating all state matters and the duty of the citizen, in doing this, each must necessarily abandon its own specialty; so that, while these organisms exist separate, as in America, each must pursue its own specialty. In no other way can the proper support of the several arbiters be maintained.

The argument, therefore, of Mr. Herbert, above quoted, against a national system of education for the reasons stated or implied, is unsound, and of no possible application. He has presented no argument against a national system of education that would not apply as well in in any other case of enforced taxation. Substitute a national system of imposts, a tariff, instead of a national system of education, and ask his questions, and the same answers must be given. Thus: "Does a national Church compel some to support a system to which they are opposed? So does a national system of imposts. Does the one exalt the principle of majorities over the individual conscience? So does the other. Does a national Church imply a distrust of the people, of their willingness to make sacrifices, of their capacity to manage their own affairs? So does a national system of imposts." Now, it is evident that the results here arrived at prove nothing more than this: that an enforced tax, however imposed, must necessarily result as stated; some will be opposed, majorities will be exalted, and even some slight foundation afforded for the startling implication of distrust in the voluntary action of the people, as a whole, in the matter concerned.

But we can not conclude that this religious argument in any way militates against the argument in favor of national education. The argument in favor of a national tariff, though oppressive to some, is only such oppression as minorities must endure in any species of legislation, whether for the promotion of virtue or the suppression of vice. But there is still a more complete answer to this religious argument, as used by Mr. Herbert. Over matters of *conscience* the higher law has dominion; but only over intentional acts has human legislation any rightful control. The control of men's actions lies *within*, but

the control of men's consciences *without*, and beyond, the scope of human legislation; so that state education is a legitimate subject of state control, while the support of a national Church is altogether beyond the sphere of national authority.

THE BLOOD AND ITS CIRCULATION.*

By HERMAN L. FAIRCHILD.

IN vertebrates alone is there a closed circulation—a complete system of tubes from whence the blood never escapes into the body-cavity. We find an approach to it in the higher mollusks. Indeed, in power and general efficiency, the circulation of the highest mollusks is greatly superior to that of the low vertebrates. Nevertheless, the perfectly closed circulatory system of even the lowest vertebrates is of higher type. Although the circulating system of the vertebrates is perfected in principle, it still admits of very great and curious modifications.

There exist in vertebrates three sets of capillary blood-vessels, which are usually spoken of as three systems, although together they constitute but a single circuit. They are distinguished as the body or systemic circulation, the respiratory or pulmonary circulation, and the liver or portal circulation. Connected with the blood-system by the thoracic duct is the lymphatic circulation.

The lymphatic system, which has previously been mentioned as the second source of blood material, deserves some notice on account of its intimate relation with the blood system of the vertebrates. The lymphatics are minute capillary vessels, found in all parts of the body of vertebrates, excepting, perhaps, the bulb of the eye, the cartilages, and the bones. They unite to form, with the lacteals, the *thoracic duct*, which was described in the article on digestion, in the September number of the "Monthly."

The office of the lymphatics is to collect the waste matter of the tissues and return it to the blood, to be again used elsewhere, or, if wholly useless, to be excreted from the body. They also collect the blood which may be poured upon the tissues in excess of their needs. The fluid which the lymphatics carry is called *lymph*. It is colorless, and contains corpuscles resembling the white corpuscles of the blood.

The lacteals, which take the new food from the intestines, are lymphatics modified for a special purpose, and, when they are not busy with the chyle, they also carry lymph.

The lymphatic tubes are provided with valves to keep the lymph flowing toward the larger trunks.

* Concluded from page 468.

This lymphatic system of the vertebrated animals is, however, expressed in technical language, only the differentiated interstitial sinuses of the lower animals, which has, in the latter, a share in the venous circulation. Indeed, in the lower vertebrates the lymphatic tubes frequently assume the form of large sinuses, and connect with the veins. They are even found in the birds. In the frog four of these sinuses have muscular walls, and rhythmically contract. These are known as lymphatic hearts.

In various parts of the body the lymphatics form glands, such as the thymus, thyroid gland, and the spleen.

Fishes have a heart resembling that of the mollusks. It is a double force-pump, consisting of a receiving-chamber (auricle), and a propelling chamber (ventricle), with all the valves necessary to prevent a backward flow of the blood. But this heart is respiratory—it sends the blood directly to the breathing organs; consequently, it passes only impure blood. When the blood has traversed the gills and is purified, it passes around the circuit of the body through the systemic and portal capillaries, and back to the heart without any further propulsion.

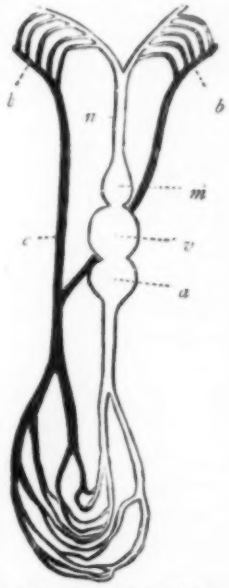


FIG. 1.—DIAGRAM OF THE CIRCULATION IN A FISH. (The portion of the system containing pure blood is black; the part containing impure blood is white.) *a*, auricle, receiving venous blood from the body; *v*, ventricle; *m*, bulbus arteriosus; *n*, branchial artery, carrying venous blood to the gills (*b*, *b*); *c*, aorta, carrying arterialized blood to all parts of the body.

The low, worm-like fish, lancelet, or amphioxus, has no special heart, but a number of contractile bulbs in the veins. The eel has such an auxiliary heart in its tail, while the hag has the circulation aided by the contractility of the portal vein.

Lepidosiren, one of the mud-fishes, approaches the amphibians in the possession of two auricles; for, in addition to gills, it has true lungs. The vein conveying the purified blood from the lungs joins the left auricle.

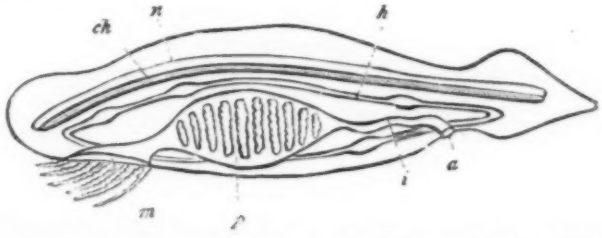


FIG. 2.—DIAGRAM OF THE LANCELET (*Amphioxus*). *m*, mouth, surrounded by cartilaginous cirri; *p*, greatly-dilated pharynx, perforated by ciliated clefts; *i*, intestine; *a*, anus; *h*, blood-system, with pulsating dilatations; *ch*, notochord; *n*, nervous cord.

Amphibians and reptiles exist under conditions incompatible with a high temperature of the body. In the adult state they are air-breathers, and, if their circulation were complete, they would be "warm-blooded." But the temperature is subdued by imperfect circulation, which results from the arrangement of the heart-chambers. There is but one ventricle for the two auricles, hence the pure blood from the breathing organs and the impure blood from the body are mingled, so that, besides the venous and arterial, they have a mixed blood. The blood which goes to the lungs is never wholly impure, and that which goes to the body is never entirely pure. However, by a complex and beautiful action of the parts and valves of the heart—too complex to be here described—the mingling of venous and arterial blood is not complete.

The change which the amphibians undergo in outward form, from the tadpole or larval state to the frog-like condition, is accompanied

FIG. 3.

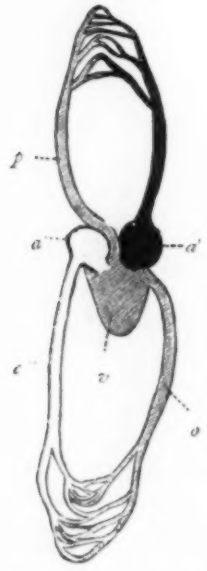


FIG. 4.

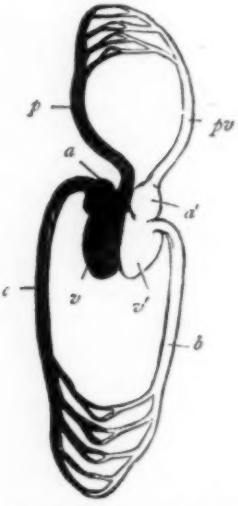


FIG. 3.—DIAGRAM OF THE CIRCULATION IN A REPTILE. (The part containing pure blood is black; that containing impure blood is white; and that containing mixed blood is cross-shaded.) *a*, right auricle, receiving impure blood from the body; *a'*, left auricle, receiving pure blood from the lungs; *v*, ventricle, containing mixed blood, which is carried by the pulmonary artery (*p*) to the lungs, and by the aorta (*o*) to the body.

FIG. 4.—DIAGRAM OF THE CIRCULATION OF A BIRD OR MAMMAL. (The venous system is black; the arterial system is white.) *a*, right auricle; *v*, right ventricle; *p*, pulmonary artery, carrying venous blood to the lungs; *p v*, pulmonary veins, carrying arterial blood from the lungs; *a'*, left auricle; *v'*, left ventricle; *b*, aorta, carrying arterial blood to the body; *c*, vena cava, carrying venous blood to the lungs.

by a remarkable inward change in the circulation. In the larval stage, with respiration by gills, the heart and circulation resemble that of the fishes—a single auricle and ventricle and complete purification of the blood. But, as the gills disappear and the lungs devel-

op, and the blood is diverted from the former to the latter, there is a corresponding change in the carrying capacity of the blood-vessels, resulting in the final disappearance of the vessels connected with the gills. Moreover, while the blood was not returned directly from the gills to the heart, it is returned directly from the lungs, and a second auricle is developed. But the aërial respiration of the frog, with its mixed circulation, is more rapid than the aquatic respiration with the perfect circulation of the tadpole.

In the reptiles circulation is essentially the same as in the amphibians; but the ventricle is more or less divided by a partition into two chambers. This membranous partition is perfect only in the crocodile, where we find a right and left ventricle without communication, and the heart structurally like that of a bird or mammal. But the circulation is still the same as in the lower reptiles, for the pure and impure blood are somewhat mingled by a communication between the two arteries near their point of origin.

Although birds in their general organization are closely allied to reptiles, their circulation is similar to that of the mammals. In these

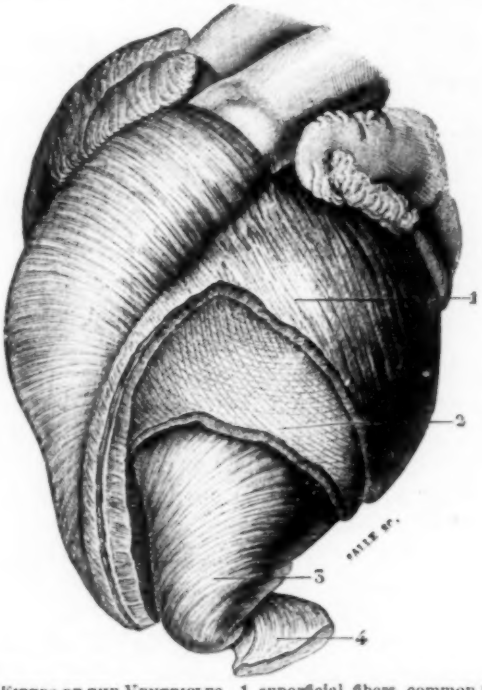


FIG. 5.—MUSCULAR FIBERS OF THE VENTRICLES. 1, superficial fibers, common to both ventricles; 2, fibers of the left ventricle; 3, deep fibers, passing upward toward the base of the heart; 4, fibers penetrating the left ventricle.

two highest classes of the animal kingdom, there are always two auricles and two ventricles, and the right and left sides of the heart are entirely distinct. Functionally these are two hearts: a systemic heart,

forcing pure blood to the body; and a pulmonary, forcing impure blood to the lungs. The pure and impure blood are never mingled, and all the blood has to pass through the lungs and be oxygenated every time it makes the complete circuit. This perfect circulation, with aërial respiration, produces more rapid chemical changes in the blood and tissues, and consequently the higher temperature of the "warm-blooded" animals. In the embryonic stages of the heart, the septum dividing the auricles is slowly formed, and an aperture exists for a time, called the *foramen ovale*. Cases rarely occur of human subjects in which the opening persists. Such persons are physiologically reduced to the condition of a reptile. It is stated that human infants have lived several days with a circulation as mixed as that of a frog.

To economize space and muscular effort, these two hearts are formed of the same circular muscles, and are inclosed by a lubricating membrane called the pericardium. In the dugong, however, the two ventricles are quite separate, showing a structural distinction corresponding with the functional difference.

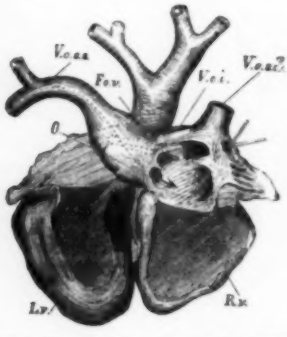


FIG. 6. — DORSAL VIEW OF THE HEART OF THE DUGONG (*Halicore*), ITS CAVITIES BEING LAID OPEN, SHOWING THE SEPARATION OF THE VENTRICLES. *R v*, right ventricle; *L v*, left ventricle.

On account of the structural union, the two hearts contract and dilate in unison, producing the "beating" of the heart. The cause of the first sound in the heart-beat is uncertain, but it occurs at the time of the ventricle contraction. The second sound is produced when the ventricles dilate, by the flapping back of the semilunar valves, those placed at the origin of the arteries to prevent the regurgitation of the blood.

Each half of the heart of birds or mammals is, like the entire heart of the fishes, a double force-pump, with perfection of valves and tubes and surpassing efficiency. The power is enormous. It has been estimated that, while an engine can lift its own weight three thousand feet in an hour, and an active climber can ascend four thousand feet, the human heart performs hourly a labor equal to lifting its own weight twenty thousand feet. Its daily work is also estimated at seventy-five thousand kilogramme-metres. We can otherwise gain an idea of the power of Nature's enginery, by observing what the heart actually performs. The quantity of blood in the human body is at least six quarts. In its course it has to traverse many feet of tubing and two sets of capillaries, and, notwithstanding the friction and loss of power, all the blood completes the circulation in about thirty-two heart-beats. We should further observe that the heart never rests, but is ceaseless from birth to death. Its cessation is death.

The necessity of uninterrupted action of the heart requires that it

should be involuntary, and so its action is placed beyond our control. It is said that an individual once lived who could stop for an instant, at will, the beating of his heart. But, it is also stated in connection, that he died as the result of a too successful attempt.

The flow of blood through the arteries by successive impulses is facilitated by their branching at acute angles. Veins, on the contrary, branch at greater angles, which is compatible with a steady and slower flow. As the veins carry in any given time the same amount of blood as the arteries, while the rate of flow is slower, it follows that their diameter or capacity is greater.

The pressure of the blood-current diminishes from the heart. In the carotid artery of man it is probably equal to the weight of one hundred and fifty to two hundred cubic millimetres of mercury. The pressure in the pulmonary artery is only thirty to forty cubic millimetres.

There is much disagreement among writers regarding the velocity of the blood. In the carotid artery of the horse, it probably flows at the rate of about three hundred millimetres per second; in the dog, at the rate of three hundred to five hundred millimetres. The velocity in the large arteries of man can hardly be over twenty inches per second, but varies greatly at different times. The length of the capillaries is about one half of a millimetre, and the blood passes through them in about one second. In the human retina the corpuscles travel at the rate of ·75 millimetre per second. The small arteries pulsate within one sixth of a second after the main trunks; but the rate of flow is much slower than the wave-progression.

In vertebrates, the rapidity of the circulation is generally proportionate to the activity of the animal. The pulse of aërial birds is about 150 per minute; of the cat, 115; dog, 95; man, 72; ox, 35. But this generalization does not hold with the invertebrates. Insects, the most active of all creatures, have a very sluggish and imperfect circulation, for in this class the air is so freely admitted into the body as to obviate the necessity of great movement of the blood.

The human pulse is somewhat more rapid in childhood, and again in old age; slightly faster in the evening than in the morning, in summer than in winter, and probably increases with geographical altitude. In fever the circulation is very greatly and mysteriously quickened.

All the blood of a man probably completes the round of the circulation in about thirty-two heart-beats, or in less than half a minute. The blood of a horse, it is estimated, completes the circuit in thirty seconds, that of a dog in fifteen, and that of a rabbit in seven seconds.

The velocity of the blood decreases from the ventricles toward the capillaries, and then increases from the capillaries toward the auricles. The velocity being necessarily the reverse of the carrying capacity, or

sectional area. The capillaries have a sectional area several times that of the aorta, the purpose of this being to delay the blood at the time it is brought into most intimate contact with the tissues.

The walls of the capillaries are of extreme tenuity, and easily permeable under the physical action called osmosis. Even the corpuscles can pass outward through the walls.

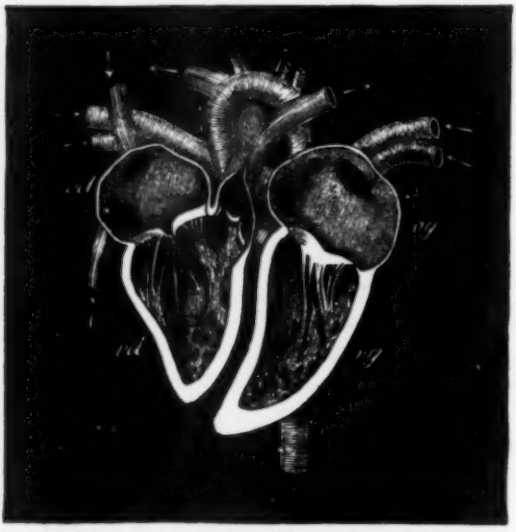


FIG. 7.—DIAGRAM OF THE FOUR CAVITIES OF THE HUMAN HEART. *o d*, right auricle; *v d*, right ventricle; *o g*, left auricle; *v g*, left ventricle. The arrows indicate the course of the blood.

To what degree the heart is aided by other forces is yet a matter of investigation. Probably there are several forces assisting. The elasticity of the arteries increases their carrying capacity. They are firm, elastic tubes, which expand under the pressure from each heart-contraction, and then by their own elasticity contract and help the onward flow of the blood. In the smaller arteries the flow loses the intermittent character it possesses in the larger arteries, and becomes a steady stream. The elasticity of the arteries serves precisely the same purpose as the air-chamber of any force-pump, that of equalizing the flow, and so increasing the amount delivered. The whole force is derived from the heart; the arteries cause the force to act continuously.

The veins are lax tubes, somewhat larger than the arteries, and capable of holding all the blood of the body. They convey the same amount of blood as the latter, but more slowly. In the larger veins, however, near the auricles, the velocity may be two hundred millimetres per second. They are provided with valves which effectually prevent the blood from flowing backward toward the heart. Any compression, produced by muscular contraction, or otherwise, will therefore assist the forward flow of venous blood. This is one explanation why

exercise hastens the circulation. The movement of the chest in breathing probably aids the pulmonary circulation, the blood, as well as the atmosphere, tending to fill the vacuum during inspiration.

Physical capillary force is not generally regarded as an active force in the circulation. But there is an admitted force in the capillaries, resulting from the attraction of the tissues for the arterial blood, containing the required oxygen and nutriment. "The vital condition of the tissue becomes a factor in the maintenance of the circulation." It is this force, primarily, which adapts the amount of blood to the varying needs of any organ; the nervous system regulates the supply by varying the caliber of the vessels.

The force in the capillaries, or some other force, carries the blood, after death, from the arteries, where the heart leaves it, into the veins.

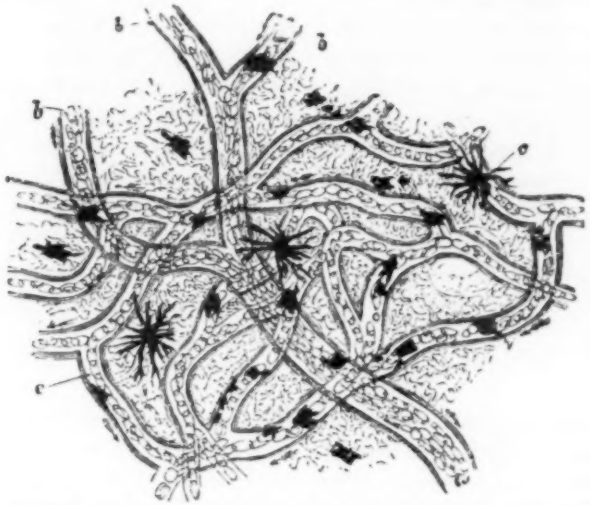


FIG. 8.—CIRCULATION IN THE WEB OF A FROG'S FOOT. The black spots, some of them star-shaped, are pigment, or coloring-matter. *a*, a venous trunk, composed of three principal branches (*b*, *b*, *b*), and covered with a plexus of smaller vessels (*c*, *c*).

Finding the arteries empty after death gave rise to the idea that they conveyed only air; whence the name. It was this belief which Harvey overthrew in 1620.

In bats the heart is aided by the rhythmic contraction of the veins in the wing. Other accessory hearts of the lower animals have already been mentioned. In some of the lowest creatures, the cause of the circulation may be wholly the movements of the body, as in the jelly-fish and anemone; or by cilia, as in the sponge, where the sea-water answers to blood.

Under the influence of nerve-force, the walls of the arteries and capillaries are usually somewhat contracted. The withdrawal of nerve stimulus allows the tubes to relax, which consequently permits more blood to pass through, or to accumulate, and perhaps add color to

the skin. This is the physiology of blushing. Congestion is produced by a permanent expansion of the capillaries. We might call blushing a momentary congestion.

In an emergency the arteries are capable of great expansion. They are connected by branches, or loops; and, in case of stoppage of the circulation in a large artery, either by disease or a surgical operation, another will, after a time, perhaps a few hours, expand to a size requisite to carry sufficient blood. This variation in the carrying capacity of the arteries is the important secondary means of adapting the amount of blood to the wants of any part of the body.

In man there is a greater and more direct supply of blood to the right arm, corresponding to the greater use of that limb. But, in birds, equality of supply is necessary for the equality of strength needed in steady flight.

For protection, the arteries are as deep-seated as possible, lying beneath the muscles, and appearing rarely at the surface. At the joints they form loops, so that the circulation may not be stopped by compression of a single trunk. A fine example of adaptation is seen in the arm of the lion, where the main artery, to be protected by the powerful muscles, passes through a perforation in the bone.

ABOUT MEASURES OF LENGTH.

By ROMYN HITCHCOCK.

FEW realize the great practical importance of extreme accuracy in standards of weight and extension, and it is not generally known what degree of accuracy has been attained in the measurement of the standards of length now in use in different countries. The carpenter's foot-rule and the tailor's yard are familiar articles, but, if asked, probably neither the carpenter nor the tailor could tell whether there is any means by which the true length of a foot or a yard can be determined. It is clear, however, that there must be a standard with which the common measures should be made to agree, in order to have the same absolute value. But we may reflect that the constant use of any measure will change its length, and that it will eventually become worn out. We can, then, readily understand the great value of an accepted standard, from which copies can be made, thus preventing any gradual alteration in our measures. Such standards of reference are properly held in the custody of national governments, scientific societies, and institutions.

It is by no means a simple process to compare one measure with another, and to determine the variation between the two. On the contrary, the utmost skill and long experience are required for such

work, as well as the most elaborate and costly apparatus. Allowance must be made for errors that are so small as to be almost inappreciable, but which can not be eliminated until they have been subjected to future investigations of a very delicate nature. Every careful observer will obtain results which are almost marvelously accordant *inter se;* but the results obtained by two observers, with different instruments, will probably not agree. The "personal equation" has not yet been eliminated from work of this kind.

In the comparison of weights and measures, science demands the utmost accuracy, and it would not be possible, even if it were desirable, in an article like this, to more than allude to a few of the steps which have resulted in the final adoption of national and international standards. Professor W. A. Rogers, of Harvard Observatory, has devoted himself to a critical study of measures of length, and to him we are indebted for many observations on the subject, of great scientific importance, and for some very ingenious devices for making accurate comparisons of spaces. He has recently published a valuable contribution to the literature of the subject,* in which the present state of the question of standards of length is discussed with considerable detail.

As the comparisons of measures of length are made with microscopes, the results are affected by the magnification and by the method of illumination employed. The measurements are made so carefully that the standard metal bar upon which the graduations are made must be carefully supported on rollers, mutually connected by a system of levers, so that no flexure can take place, or else a bedplate must be so carefully adjusted in an horizontal plane that no effect of flexure can be detected. Professor Rogers has adopted the latter plan, and he believes that no part of the bedplate of his comparator is more than ·00002 of an inch from the true level.

In constructing a standard, the shape of the bar and the material of which it is composed require careful consideration. In a few cases, standard bars seem to have undergone some molecular change by which their length has been altered. As an example, we may cite this instance: A Russian standard, which was used at one time in geodetic surveys, after it had been transported for a distance of about eight thousand miles, was found to have shortened in length by about one six-thousandth of an inch. This bar was of iron, about seven feet long.

The influence of temperature upon the length of a metal bar is very noticeable, when careful measurements are made. Not long ago, before our knowledge of this subject was as complete as it is now, it was assumed that, if two bars were allowed to remain in a liquid maintained at a certain temperature, they would soon acquire their

* "Proceedings of the American Academy of Arts and Sciences," vol. vii, New Series, p. 273.

true length for that temperature. Is has lately been shown, however, by the experiments of Professor Rogers, that if two steel bars, one of which is nickel-plated, be subjected to a gradual change of temperature, they will acquire their true length after the temperature has been maintained constant for about twelve hours; but, if the change be an abrupt one, it is not safe to compare them until after the lapse of from forty-eight to sixty hours.

Enough has been said to indicate what great precautions must be taken in order to obtain accurate copies of a given standard of length. We may now consider how the standard measures at present in use were originally obtained, and how they are related to each other. We will confine our attention to the measures of France and England, since these possess more interest for us than do the measures of other nations, with which we are less familiar.

It is quite generally supposed that the length of a yard exactly corresponds to the length of a pendulum beating seconds of time, in a vacuum, in the latitude of London, at the sea-level. This, however, is not the fact. The act of Parliament in relation to this matter has been generally misunderstood, for it does not declare the length of the yard to be absolutely that of the pendulum; in truth, these lengths are not the same. Parliament only provided that, in case the original standard should be lost, it could be restored by reference to the unit-pendulum. The standard that was legalized was made by Bird, from Graham's scale, in the year 1760. It was named the "imperial standard yard."

According to experiments conducted at that time, it was found that the relation between the length of the standard imperial yard and that of a seconds-pendulum was in the proportion of thirty-six inches to thirty-nine inches and $\frac{1393}{10000}$ of an inch. On October 16, 1834, both Houses of Parliament were destroyed by fire, and, although the imperial yard was found in the ruins, it had become unfit for use as a standard. The problem of its restoration was then presented, but since the passage of the act of 1824, which declared the relations between the pendulum and the lost standard, it had been found that the data from which the relations were calculated were, in several respects, unreliable. It was finally decided not to attempt the restoration of the lost standard by means of the pendulum, but to work from the various standards which had been compared with it. For this purpose six different scales were found available, among which was the tubular scale belonging to the Royal Astronomical Society; but this scale was not the principal authority from which the new standard was constructed, although it is so asserted in both Appletons' and Johnson's Cyclopædias. The scales actually made use of were two by Shuckburgh, one by Kater, that belonged to the Royal Society, and two bars of the Ordnance Department. The work of renewing the standard was intrusted to Sir Francis Baily, but he died

before completing it, and was succeeded by the Rev. R. Sheepshanks. That gentleman first constructed a bar of brass, which he found to measure 36·00025 inches, in terms of the lost standard. From this the present "imperial standard yard" known as "bronze 19" was made.

Before Sir Francis Baily died, he proposed the use of an alloy for standard measures, which is known as Baily's metal. It is composed of sixteen parts of copper, two and a half parts of tin, and one part of zinc. "Bronze 19" was made of Baily's metal; it is thirty-eight inches long, one inch wide, and one inch deep. The graduations are upon gold plugs that are sunk into the bar. The lines are sharp, and are very well adapted to accurate measurement; they are about $\frac{1}{3000}$ of an inch in width. This standard was legalized by act of Parliament on July 30, 1855. The original standard "bronze 19," or, as it is also called, "No. 1," is kept in the "Strong Room" of Old Palace Yard. Four copies of it are in existence: one is at the Royal Mint, one is in charge of the Royal Society, one is in the new Westminster Palace, and the last is at Greenwich Observatory. Forty other copies were made in Baily's metal, and these have been distributed among different Governments, but only two of them are standard at the same temperature as the original.

From what has been stated, it will be observed that there is no natural unit from which our yard-measure has been derived; it is merely an assumed unit of length which has been declared a legal standard by the British Parliament.

The yard-measure of the United States, with which all measures to be verified are now indirectly compared, is known as "bronze bar No. 11," which was presented to the Government by the British Board of Trade in the year 1856. It is standard at 61·79° Fahr. It does not appear, however, that our Congress has ever sanctioned the use of this standard by any enactment. The only standard yard ever legalized by that body seems to have been a copy of a part of an old scale by Troughton, which had been used by the Treasury Department previously to 1856.

There is now a strong movement in favor of the general adoption of the French system of weights and measures in this country. The efforts that have been made to attain this very desirable result have met with great opposition, but this is steadily giving way before rational argument and sound elementary instruction, so that we may safely predict that our very irrational divisions of feet, inches, pounds, and ounces will eventually be abolished, and that a decimal system will take its place. There is a standard metre bar in the possession of our Government, but it has not been declared a standard by Congress, although it is used for comparisons.

The French metre was originally supposed to be equal to the one ten-millionth part of the quadrant of a meridian of the earth passing through Paris. An arc of a meridian which extends from Dunkirk to

Barcelona, running through Paris, was very carefully measured by Messrs. Méchain and Delambre, and, by comparing their results with measurements that had been made of other arcs, they were able to obtain the length of the meridional quadrant of Paris. Four iron bars were then prepared, and their ends were ground and polished until they were of the required length, to represent one ten-millionth part of the quadrant, or one metre. One of these is now in the possession of the United States, and it is supposed to be the only one in existence. One of the original bars was chosen as the standard of France, and the metre of the French Archives was made directly from it, and at the same time two other similar bars were made, one of which is the metre of the Conservatoire and the other is the metre of the Observatoire. These bars are made of platinum.

In the year 1870 a Commission was formed at Paris, which is known as the "Commission Internationale du Mètre." This Commission, after mature consideration, concluded that the natural unit which had been assumed was far from satisfactory, for reasons which were well set forth in the scientific journals at the time. The Commission therefore declared, as it had full power to do, owing to its international character, that the metre of the Archives should be perpetuated for ever as the true metre. It thus appears that the French unit is no more firmly established, so far as any natural basis is concerned, than is the English yard. It may be of interest to know what relation the accepted standard bears to the length of the natural unit that was first proposed. It has been shown, by the more recent investigations of Clark and Shubert, that the Archives-metre falls short of being true to the natural unit by one fifty-four-hundredth part.

The iridio-platinum alloy, which the Commission has decided to use for standards, is "composed of ninety parts of platinum and ten parts of iridium, with an allowance of two per cent. variation more or less." In 1874 an "International Bureau of Weights and Measures" was established at Paris, to be supported by *pro rata* contributions from the signing powers. This bureau is charged with the care of prototype standards, and with the duty of constructing and verifying copies of them.

The work of preparing the prototypes devolved upon the French section of the Commission, but the International Bureau declined to accept the standards that were submitted, on the ground that the platinum-iridium alloy contained about two per cent. of iron, and was not, therefore, of sufficient purity. The work of the Bureau has been delayed on account of this unfortunate circumstance; but M. Tresca, the secretary of the French section, does not admit the validity of the objections that have been made to the alloy. The buildings of the International Bureau afford great facilities for its work; in one room, where standards of weight are compared, there is a very perfect apparatus for weighing in a vacuum. It is so arranged that the weigh-

ing can be done from a distance of about eight metres (over twenty-five feet) from the balance. In the room where standards of length are compared, there is a comparator which cost about three thousand dollars, and another one is probably completed by this time, which is worth five thousand six hundred dollars.

It seems strange that the precise relation existing between the imperial standard yard and the metre of the Archives is not known. Nevertheless, it is true, for the two measures have never been directly compared. No equation can be assigned to them that is not likely to be erroneous by at least ·005 of an inch; but, in the year 1878, Parliament declared that the legal value of the metre, in inches, should be 39·37076.

It may be thought that so small an error as five one-thousandths of an inch, in a bar more than three feet long, is not worthy of serious consideration; but the fact is, that any error that can be detected by the most refined instrumental means is of great consequence, especially for scientific work. The error mentioned above will appear as a relatively large one, when we state with what accuracy minute measurements may be conducted. Professor Rogers considers that the error in comparing the length of two metre bars need not exceed the one-millionth part of a metre. In terms of an inch this error, expressed in figures, would be ·0000039. In testing the performance of his excellent comparator, he found the value of a centimetre, in terms of an inch, to be ·393707. The generally accepted value is ·393708, which indicates a truly wonderful degree of accuracy in the instrument.

Professor E. W. Morley has made some experiments to determine the probable error in micrometric measurements, and he has found that the errors of a single observer, under the particular conditions described, were very small. With a low-power object-glass, the probable error does not exceed thirty-nine ten-millionths of an inch. With a greater magnifying power he found it to be about thirty millionths of an inch. These errors, inconceivably small as they are, can be made appreciable by means of a microscope.

ARE CEMETERIES UNHEALTHY?

By M. G. ROBINET.

IF the tomb is characteristic of humanity, as Vico has said, the cemetery, M. Pierre Lafitte remarks, is absolutely necessary to all human society. It not only furnishes a more or less hygienic method of disposing of the bodies of those who are no more—it is also a fundamental institution, in the sense that it is a symbol in no way arbi-

trary of human continuity. The cemetery ought, therefore, in every city to be preserved and improved, as something indispensable to the intellectual and moral improvement of the people. It constitutes an interest of the first order, the care of which justifies all necessary efforts and expenditures. With a large part of the public, however, hygienic considerations far outweigh all the moral and social advantages to be derived from the maintenance of cemeteries; and, in justice to the views of this class, it is proper to inquire to what extent the existence of cemeteries, in or near a city like Paris, can be dangerous to the public health.

The injurious effects attributable to cemeteries can be exhibited only through the air, the soil, and the waters. Let us examine each of the three cases.

The air may be contaminated by the disengagement of poisonous gases, or by the propagation of miasms.

The decomposition of bodies in the earth is a real organic combination; its products are quite well known. The principal and most abundant of them is carbonic acid, a substance that is generated by the slow combustion of the carbon contained in all organic matter, vegetable or animal, whether it be a blade of grass, a leaf, wood, manure, or a dead body. It may be disengaged from the soil in cemeteries, and most hygienists have till now considered it one of the principal causes of their insalubrity. This is a mistake. We have on a recent special occasion made an approximate calculation of the maximum quantity of carbonic acid that can be produced in the cemeteries of Paris. The results of these calculations, which are based upon numerous weighings of corpses made in several hospitals and on the most authentic data of the chemical composition of the human body, show that this quantity is infinitely less considerable than has been supposed. The total weight of the bodies consigned each year to the cemeteries in Paris is 1,389,000 kilogrammes (3,472,500 pounds). If all their carbon were transformed (which is not the case) and disengaged as carbonic-acid gas, they would furnish 1,257,000 kilogrammes (3,142,500 pounds) of that gas in five years. Now, according to the calculations of M. Boussingault, we may estimate the quantity of carbonic acid produced in Paris, by the respiration of men and animals and the different processes of combustion, at 18,000,000 kilogrammes (or 45,000,000 pounds) in twenty-four hours. The combustion of illuminating gas alone in Paris (218,813,875 cubic metres) produced last year a quantity of carbonic acid thirty-five hundred times more considerable than all the dead buried in the cemeteries during five years could give at the maximum rate of exhalation. The Grand Opera-House alone gives out every year thirteen times more carbonic acid from its gaslights than could be disengaged from all the cemeteries put together, even if all their carbon were converted into gas.

After examining these figures, and comparing them with the very

precise experiments recently made by MM. Jules Reiset, Muntz, and Aubin, on the proportion of carbonic acid in the atmosphere, which go to show that the proportion of this gas in the air of Paris is no more considerable than in the country, we have a right to affirm that positively no danger to the public health exists from this source.

The truth is, that most of the accidents which happen in burial-places must be attributed only to confined carbonic acid. These accidents are, moreover, much less numerous than is supposed. Different authors do not report more than twelve or fifteen cases, and the theory that cemeteries are centers of infection has been built upon this small basis. Such accidents have been attributed to "pestilential emanations, to certain subtile and deleterious gases, to unhealthy miasms," etc. In reality, the accidents noted have been caused by the carbonic acid which has settled in the pits or vaults by virtue of its superior specific gravity. The same happens much more frequently than in cemeteries, in lime-kilns, marl-pits, some cellars, fermenting vats, everywhere, in short, that carbonic acid is liable to accumulate within a limited space.

The absence of any facts relative to other gases than carbonic acid that might be disengaged in the course of cadaverous decomposition ought to have made those who are so sure of the dangerous character of cemeteries more circumspect ; notwithstanding there are no such facts, these persons, besides magnifying the dangerous consequences of the liberation of carbonic acid, speak also of the no less fearful dangers which result from the generation of "certain gases and of certain volatile products." Only two gases have been found to be present to an appreciable extent in the confined air of mortuary vaults, or in the atmosphere immediately surrounding a body in decomposition—as, for instance, within the inclosure of a leaden coffin. These two gases are poisonous when breathed in a certain quantity ; they are ammonia and sulphuretted hydrogen, forming, when they combine, sulphohydrate of ammonia. The most delicate reagents disclose no trace of these gases in the free air, nor even in the atmosphere of the cemeteries of Paris, although such tests often, when applied in the same manner, indicate their presence in water-closets, sinks, cellars, and sewers. In the absence of ammonia and sulphuretted hydrogen, we might (though no one has yet done so) imagine the presence of the *ptomaïnes*, those alkaloids of dead bodies recently discovered by Professor Selmi. We anticipate this accusation, by observing that the presence of ptomaïnes in the open air has never been detected. It has been proved that they are not always poisonous ; and they exist only in inconsiderable quantities. So far as is known, the ptomaïnes may be simply resultants of the transformation of other principles during extraction, for "they sometimes exhale a perfume like that of certain flowers, as the orange or wild-rose, and of certain aromas"—odors which it is well known are not found among those of cadaverous pu-

trefaction. Moreover, these alkaloids, according to Selmi, are readily decomposed in contact with the air. The ptomaïnes, then, can not enter into account in establishing a noxious character for cemeteries.

Assuredly there are miasms. We do not mean by this term those famous entities by which populations have been struck with terror, but those infinitely small, inferior organisms, the *microbes*, whose existence can not be disputed after the brilliant investigations of contemporary micrographs, especially those of M. Pasteur. We have no disposition to ignore the existence of four or five species of microbes, the destructive effects of which appear to be well established, such as the anthrax-bacteria, the septic vibrion, Obermeyer's spirill, the micrococcus of the hen-cholera, and some other less well-known bacteria. But, without denying that the air may convey infectious germs, and that these may penetrate into the human organism through various channels of absorption, facts which have become almost classical, we still have to examine whether cemeteries, more than other places, give rise to these miasms, these legions of microbes, whose presence in considerable numbers in certain places, notably in hospital-wards, is incontestable.

A number of well-established facts go to prove that the different germs are destroyed by the combustion of corpses in the earth as soon as putrid fermentation begins. We cite the characteristic fact of the disappearance of the carbuncular virus in the bodies of animals that have died of the plague-sore, from the moment the body begins to putrefy (Pasteur, Collin), a fact which is practically recognized by all the horse-killers, who are aware that infected subjects shortly after death cease to be dangerous to them. A more important fact is that the very exact micrographic researches undertaken by M. Miquel in the cemeteries of Paris have certainly shown that there do not exist in them any centers specially productive of germs of cryptogams. This learned physician has ascertained, contrary to the opinion of many authors, that the vapor of water which arises from the soil, from rivers, and from masses in active putrefaction, is always micrographically pure—that is, it contains no microbes; that the gases proceeding from buried matters in decomposition are always free from bacteria; that even the impure air which is caused to pass over putrefied meats, instead of being charged with microbes, becomes fully purified, on the single condition that the infectious and putrid filter is in a condition of humidity comparable to that of the ground at about a foot below the surface. Finally, none of the numerous species which M. Miquel has isolated and inoculated upon living animals has shown itself capable of determining pathological troubles worth mentioning. After this, we may with perfect security put aside those pretended miasmatic emanations, those mysterious effluvia with which certain hygienists have gratuitously frightened an inexperienced public, and which some speculators have turned to good account for themselves.

Regarding the extent to which the soil is affected in consequence of burials, we are in possession of exact and well-established facts. The time required for the earth fully to transform organic matter that may be buried in it varies according to the physical and chemical nature of the soil: in some grounds bodies are, we might say, devoured in a few days; more commonly the time required to transform a corpse is estimated at from five years, as in Paris, to twenty years, as at Geneva, and even more in some places. Authors also differ respecting the time needed for the operation: Gmelin and Wildberg believed that it takes thirty years, while Maret thought that three years are enough.

Legislation based on this point has designated a variety of periods after which burial-grounds may be used over again. At Frankfort, thirty years is the standard; at Leipsic, fifteen years; at Milan and Stuttgart, ten years; at Munich, nine years. Generally, the time necessary for a complete destruction of the body is estimated in France at five years, but this limitation is not at all absolute, and in many cases burial-grounds may be used anew before that time. In the majority of the experiments made by them, Orfila and Lesueur found that bodies were reduced to skeletons at the end of fourteen, fifteen, or eighteen months. After that time, the soil under the vivifying influence of oxygen resumed its original qualities.

On this point, we may assert, contrary to certain affirmations, but in accordance with experiments the importance and value of which are guaranteed by the name of the author, M. Schützenberger, that, so far as the cemeteries of Paris are concerned, no saturation of the soil, either with gases or with solids, exists. The recent experiments of this chemist have resulted, in effect, in showing that the soil in the Parisian cemeteries is still in a sufficiently favorable condition as to its composition to effect the absorption of the gases and the complete transformation of the solid and liquid matters resulting from the putrefaction of the bodies that may be buried in them. The analysis, so far as it refers to gases at least, has given identical results with the analyses of good arable lands. Moreover, there is nothing to prevent the modification of the soil of cemeteries by means of suitable applications for augmenting the intensity and rapidity of its combustible force. Such applications are certainly not beyond the means of modern agricultural chemistry.

No important instance of the contamination of waters has been established against the cemeteries. Cases of an exceptionally unfavorable influence of a mass of decomposing matter on certain waters may occasionally occur, but none such have been established in the soils of Paris, and those which have been described in other places are not conclusive. What, on the contrary, most evidently comes out after a study of the facts is the remarkable purifying power that the earth possesses. It would take too long to give here the proof that water is not infected by cemeteries; we mention only the case of the well in

the cemetery of Montparnasse, the water of which is shown by chemical analysis to be of excellent quality.

With respect to the inferior organisms which some persons believe may be conveyed away by water that has traversed the soil of cemeteries, we may say that M. Pasteur has shown that the waters of springs issuing from the ground even at a slight depth, are so destitute of germs that they can not fertilize the liquids which are most susceptible of change. Such waters, says M. Pasteur, "are at the base of lands which have been traversed incessantly for centuries by streams, the effect of which has been constantly to cause the finest particles of the superposed soils to descend to the springs. The latter, in spite of these favorable conditions for polluting them, remain indefinitely of a perfect purity, a manifest proof that a certain thickness of earth arrests all the finest solid particles."

The wells in Paris being hardly ever used, they ought to be infected by the nitrates which, supposed to be introduced into them, are not drawn from them. It is, however, far from being proved that the cemeteries contribute materially to the excess of nitrates in the well-waters, for the analyses we have made show no sensible difference from those which were made by M. Boussingault twenty years ago. The mean quantity is the same, and our partial results show sometimes a little less, sometimes a little more, saltness than those of M. Boussingault. Now, people have continued to bury, and the ultimate products of decomposition have become more and more soluble; and, if the excess of nitrates that has been observed was due to the cemeteries, it would of necessity have increased.

Besides the precise points which we have reviewed, more general and indeterminate accusations are made against the cemeteries. Such charges are connected with the prejudice, often ill-founded, under the influence of which we *a priori* attribute injurious properties to everything that smells badly. This error arises in part from the repugnant associations which are commonly attached to the substances and places from which bad smells emanate; but, while we admit that effluvia which offend the sense of smell are not agreeable, it is not true that such emanations are generally injurious to the public health.

The facts of this order, which have long served as the foundation of the accusations directed in the name of hygiene against the cemeteries, date from the last century, when chemistry and hygiene were still in the rough. No modern observation enforces them. On the contrary, contemporary scientists, who have studied the effects of animal putrefaction, are almost unanimous in regarding it as innocuous. Such is the opinion of the most authoritative modern authors, Dr. Warens, Bancroft, Andral, Parent-Duchâtelet, and, more especially with reference to cemeteries, Professors Depaul and Bouchardat.

It is hardly necessary to mention that a number of occupations expose those engaged in them to putrid exhalations, without producing

injurious results upon them. Thus, soap-boilers and chandlers are known to enjoy excellent health, and not to be subject to fevers or epidemic affections, notwithstanding they often use fat in a very advanced stage of putrefaction (Tardieu). Tanners and curriers are neither more frequently nor more seriously ill than other men, aside from the occasional carbuncular affections they may acquire by real and direct inoculation, although they are often obliged, especially in summer, to work upon hides that are green with putrefaction. The same may be said for scavengers. The gases which, confined in pits, cause asphyxia, bring no diseases upon the men when a sufficient quantity of atmospheric air is present with them. Grave-diggers, instead of being more subject than other men to febrile, contagious, or epidemic diseases, have always been supposed to enjoy a certain immunity against them. Examples illustrating this principle are not wanting. A long catalogue of them might be cited without any trouble, except to the reader, to whom the reiteration would be tedious.

In conclusion, it may be affirmed that, to the present day, not a single instance of positive noxious infection has been laid to the charge of the cemeteries of Paris. We are in a situation, therefore, to reassure the public on this point, and to deplore with the illustrious Fourcroy "the abuses which certain persons have made of the discoveries in physics and chemistry, taking advantage of them to magnify and multiply complaints against the air of cemeteries and against its effects on the neighboring residences."

Let us say, if we have not courage to support it, that the spectacle of death ought to be hidden from our sight, that in our life of feverish industrialism we have no time to spare for the dead; let us even acknowledge that we have speculative reasons for desiring to remove the burial-grounds from Paris; but let us stop invoking science, let us stop invoking hygiene; let us stop asserting that cemeteries are real centers of infection, that they are susceptible of developing the germs of the gravest maladies; let us stop frightening the ignorant public with sonorous words and phrases. It is easy enough to say and repeat that cemeteries are a source of dangerous emanations, but assertions are not proofs.—*Revue Scientifique.*

INHERITANCE.

By CHARLES DARWIN, F. R. S.

THE tendency in any new character or modification to reappear in the offspring at the same age at which it first appeared in the parents, or in one of the parents, is of so much importance, in reference to the diversified characters proper to the larvæ of many animals at successive ages, that almost any fresh instance is worth putting on

record. I have given many such instances under the term of "inheritance at corresponding ages." No doubt the fact of variations being sometimes inherited at an earlier age than that at which they first appeared—a form of inheritance which has been called by some naturalists "accelerated inheritance"—is almost equally important, for, as was shown in the first edition of the "Origin of Species," all the leading facts of embryology can be explained by these two forms of inheritance, combined with the fact of many variations arising at a somewhat late stage of life. A good instance of inheritance at a corresponding age has lately been communicated to me by Mr. J. P. Bishop, of Perry, Wyoming County, New York. The hair of a gentleman of American birth (whose name I suppress) began to turn gray when he was twenty years old, and in the course of four or five years became perfectly white. He is now seventy-five years old, and retains plenty of hair on his head. His wife had dark hair, which, at the age of seventy, was only sprinkled with gray. They had four children, all daughters, now grown to womanhood. The eldest daughter began to turn gray at about twenty, and her hair at thirty was perfectly white. A second daughter began to be gray at the same age, and her hair is now almost white. The two remaining daughters have not inherited the peculiarity. Two of the maternal aunts of the father of these children "began to turn gray at an early age, so that by middle life their hair was white." Hence the gentleman in question spoke of the change of color of his own hair as "a family peculiarity."

Mr. Bishop has also given me a case of inheritance of another kind, namely, of a peculiarity which arose, as it appears, from an injury, accompanied by a diseased state of the part. This latter fact seems to be an important element in all such cases, as I have elsewhere endeavored to show. A gentleman, when a boy, had the skin of both thumbs badly cracked from exposure to cold, combined with some skin-disease. His thumbs swelled greatly, and remained in this state for a long time. When they healed they were misshapen, and the nails ever afterward were singularly narrow, short, and thick. This gentleman had four children, of whom the eldest, Sarah, had both her thumbs and nails like her father's; the third child, also a daughter, had one thumb similarly deformed. The two other children, a boy and girl, were normal. The daughter Sarah had four children, of whom the eldest and the third, both daughters, had their two thumbs deformed; the other two children, a boy and girl, were normal. The great-grandchildren of this gentleman were all normal. Mr. Bishop believes that the old gentleman was correct in attributing the state of his thumbs to cold aided by skin-disease, as he positively asserted that his thumbs were not originally misshapen, and there was no record of any previous inherited tendency of the kind in his family. He had six brothers and sisters, who lived to have families, some of them very large families, and in none was there any trace of deformity in their thumbs.

Several more or less closely analogous cases have been recorded; but until within a recent period every one naturally felt much doubt whether the effects of a mutilation or injury were ever really inherited, as accidental coincidences would almost certainly occasionally occur. The subject, however, now wears a totally different aspect, since Dr. Brown-Séquard's famous experiments proving that Guinea-pigs of the next generation were affected by operations on certain nerves. Dr. Eugène Dupuy, of San Francisco, California, has likewise found, as he informs me, that with these animals "lesions of nerve-trunks are almost invariably transmitted." For instance, "the effects of sections of the cervical sympathetic on the eyes are reproduced in the young, also epilepsy (as described by my eminent friend and master Dr. Brown-Séquard) when induced by lesions of the sciatic nerve." Dr. Dupuy has communicated to me a still more remarkable case of the transmitted effects on the brain from an injury to a nerve; but I do not feel at liberty to give this case, as Dr. Dupuy intends to pursue his researches, and will, as I hope, publish the results.—*Nature.*

INCREASE AND MOVEMENT OF THE COLORED POPULATION.

By J. STAHL PATTERSON.

I. INCREASE.

THE problem of races in the United States is one of growing interest and of great practical moment; that of the colored race, especially at the present time, is full of significance in its social and political aspects. It is proposed in a couple of articles to inquire briefly into the phenomena of increase and movement of the colored population in the light of the most recent observations and statistics which bear upon the subject. The first table we shall consult is that which gives the increase of the white and of the colored population for each decade from 1790 to 1880:

	Year.	White.	Colored.	White gain, per cent.	Colored gain, per cent.	
1st census.	1790	3,172,006	757,208	....	....	
2d "	1800	4,306,446	1,002,037	35·8	32·3	1st decade.
3d "	1810	5,862,073	1,377,808	36·0	37·5	2d "
4th "	1820	7,862,166	1,771,656	34·1	28·6	3d "
5th "	1830	10,537,378	2,328,642	34·0	31·5	4th "
6th "	1840	14,195,805	2,873,648	34·7	23·4	5th "
7th "	1850	19,553,068	3,638,808	37·7	26·6	6th "
8th "	1860	26,922,537	4,441,830	37·7	22·1	7th "
9th "	1870	33,589,377	4,880,009	24·8	9·9	8th "
10th "	1880	43,402,408	6,577,497	29·2	34·8	9th "

It will be seen that the ratio of increase in the colored population had fallen off somewhat before emancipation, although the proportion of fugitives was less from 1850 to 1860 than from 1840 to 1850. By the annexation of Texas, 59,000 colored were added to the census of 1850. Florida was first counted in 1830, with 16,000 colored. Louisiana was purchased in 1803, adding about 30,000 colored to the census of 1810. The slave-trade closed in 1808.

The ratio of increase in the white population was less disturbed by the acquisitions of territory and people. Immigration is the very large factor which here swells the ratio of increase, and this more in later decades than in the earlier ones. During the first decade (1790–1800) the number of immigrants was about 43,000; during the second, 60,000; during the third, 98,000; during the fourth, 150,000; during the fifth, 600,000; during the sixth, 1,700,000; during the seventh, 2,500,000; during the eighth, 2,400,000; and, during the ninth, 2,800,000. It should be kept in mind that, in 1870, there were over 10,000,000 whites in the United States whose mothers were of foreign birth, being 30 per cent. of the entire white population. The tide of immigration received a check during the war (1861–'65), and also during the period of commercial depression, 1874–'79. The war, by checking immigration, marriage, and the fruitfulness of marriage, and by the outright destruction of human life, greatly reduced the percentage of increase during the eighth decade. The check which the hard times gave to immigration reduced the percentage of increase for the ninth decade below the figure it would otherwise have reached. But, after making all allowances for the advantages which immigration gives to the white population, it is probable that from 1810 to 1860 the whites multiplied somewhat more rapidly than the colored people.

The ratio of increase of the colored population, though declining, was quite uniform till the decade 1860–'70. Two classes of influences were then vigorously at work to reduce the ratio—a war which largely concerned the colored people, and the transition from the servile to the free condition. The whole decade was an unsettled period, with every influence against the rapid multiplication of the freed race. The rate of increase for that decade was a little less than 10 per cent.—less than half what it had been the previous decade. The percentage of increase for the decade 1870–'80 is quite surprising. As it has taken place under freedom, it contravenes all the prejudices and upsets most of the philosophies. One would naturally have supposed, from the reputed bad treatment and destruction of freedmen in the South and the preordained tendency of an inferior people to decline in presence of a superior, that the colored race would be dying out, instead of increasing at the marvelous rate of 34 per cent. in ten years.

Previous to emancipation, it was a current opinion, not only among slaveholders but among others, that slavery was conservative of the

colored race, owing to the interest of masters. It was expected that, with freedom, the colored people would begin to die out like the Indians. This was based on the general doctrine that, when a superior and inferior race occupy the same territory, in free competition, the inferior will go into a decline. That this was a total misconception of the subject, on theoretical principles, it would not now be difficult to show; and, that it was practically wide of the mark, the late census is abundantly sufficient to prove. Still, in the facts known previous to this census, there was much in favor of such a view. In the decades preceding emancipation, the ratio of increase of the free colored was only about half that of the slaves.

Mr. Kennedy, Superintendent of the Census of 1860, believed that freedom was unfavorable to the multiplication of the colored people. He says, "Leaving the issue of the present civil war for time to determine, it should be observed, if large numbers of slaves shall be hereafter emancipated, so many will be transferred from a faster to a slower rate of increase." He held that "the white race is no more favorable to the progress of the African race in its midst than it has been to the perpetuity of the Indians on its borders." He was of opinion that the "developments of the census, to a good degree, explain the slow progress of the free colored population in the Northern States, and indicate, with unerring certainty, the gradual extinction of that people the more rapidly as, whether free or slave, they become diffused among the dominant race."

If these were the views which appeared to be warranted by the showing of the eighth and previous censuses, they were certainly not contravened by anything in the ninth census (1870), but apparently more than confirmed; and there was much to encourage the prevailing notion that after emancipation the colored population would increase less rapidly than before. Up to the very taking of the last census this opinion had taken such hold as to enter as a factor into political calculations. It was expected by leaders of both the great parties that under the new census the South would lose relatively in Congressional representation.

Perhaps the writer may be permitted to state that, about the middle of the last decade (1875–'76), he made a leisurely trip through the South, one object of which was to study this subject. He found no physician in the South, whether native or Northern, but believed that the colored race was in a decline and slowly undergoing the process of extinction. It was believed—no doubt the result of a dominating idea which preoccupied the mind—that births were fewer and deaths more frequent than formerly under slavery. According to the census of 1870, the colored people died off more rapidly than the white, as well in the South as in the North. The report of deaths, though obviously imperfect, shows that this greater mortality of the colored takes place among the children. It was found that the cemetery

records of sextons in the larger towns of the South confirmed this showing of the census. But, for all this, all through the South, there were such swarms of little colored people about the huts, that the writer was constrained to withhold his assent to the notion that the race was dying out, stating at the time that, "notwithstanding the showing of these statistics, we suspect that the greater number of births compensate for the greater number of deaths, and that the next census returns will show little if any diminution of the relative proportion of the negro to the native white population."

It must be mentioned, however, that the showing of the last two censuses is not altogether free from suspicion. It has been thought that either the census of last June made too many colored people, or that of 1870 made too few. Where most in doubt, the last census has been retaken with care, in parts of South Carolina three times in all, and the work first done thus verified as correct. The probability is, that the census of 1880 is as accurate as such work can well be done. The census of 1870 is not so well authenticated, but it was thought at the time to be correct. Whether it failed to enumerate all the colored is a matter of speculation only, which can never be satisfactorily determined. It is now believed in the Census-Office at Washington that all the colored were not enumerated in 1870. Possibly this is the case to a certain extent, but it is just possible that it may not be necessary to suppose error in either of the censuses to account for the great increase during the last decade. The census of 1870 shows that reproduction had been greatly checked in this as in other classes ; and it shows this even if we allow a large margin for error. But this state of things rapidly changed, and the colored people of the South began life anew about the year 1870. They were no longer disturbed by the war, nor seriously molested by the lawless elements of the South. They had become comparatively well settled in their new status of freedom. They found something to do, and something that paid, as the successive great cotton-crops of the South show ; and that hopefulness in life which followed the period of anxiety contributed an unusual stimulus to reproduction. With more settled habits came marriage and rapidly increasing families. The census of 1870 shows that the proportion of children under ten years of age was nearly one per cent. less among the colored than among the native whites. This is due, no doubt, to the American-born children of immigrants being counted as natives ; but it is probable that the census report of 1880 will reverse this showing. Comparison can not be made in earlier reports because the native and foreign whites were not kept distinct.

The following is from an intelligent correspondent of Floyd County, Georgia, to the "Country Gentleman" of July 15, 1880—Mr. J. H. Dent : "So far as I have heard from the census enumerators, they report that the increase of negroes by birth is remarkable. The enumerator of this district told me that in three families he found thirty

living children, which surpasses anything of the kind among the whites. I have three negro tenants on my farm, and among them they have fourteen children ; and for health, flesh, and vigor, I would compare them with any children at the North or elsewhere." It is probable that the advantage of the colored, in the matter of numbers, comes, not from unusual conservation of the living, but from early marriages under ordinary circumstances, and the rapidity with which children are born in the same family, and also, as the census reports show, from the greater tenacity of life from middle age onward. For these reasons mortality might be absolutely greater among the colored, and they still far outstrip the whites in the multiplication of numbers. But there is nothing in the form of positive evidence to show that, in the rural districts of the South, mortality is any greater among colored than among white children.

The colored increase of the last decade, as shown by the census, does not so far transcend the increase of the early decades of the century as to render it at all incredible ; and yet, such are the conditions under which this has taken place, that it is no doubt to a certain extent exceptional, and will not be repeated in the future. It is quite safe to predict that the next decade will not show so large a percentage of increase as the last. No doubt the forthcoming "Census Report" will show a greater proportion than usual of colored children in the South from one to ten or twelve years of age. Reproduction will cease in a considerable percentage of these families before the close of the current decade ; and, of those born during the last decade, not a very large proportion will marry before the beginning of the next decade. If this view has truth in it, and there should be no disturbing conditions, the rate of increase among the colored in the South will be greater from 1890 to 1900 than from 1880 to 1890, but not so great as from 1870 to 1880 (theory of Reichenbach ; "Report of the Eighth Census," Introduction, viii). But, however this may be, no amount of question concerning the last two censuses, the ninth and tenth, can so far invalidate them, but they show the high probability that both freedom and diffusion in peace are favorable, rather than otherwise, to the multiplication of the colored race. This is so, even allowing a good margin for error in the census of 1870. So far as the census of 1880 covers the ground, it does not afford merely the evidence of negation ; it is positive, and not likely ever to be shaken.

The aggregate white population of the sixteen Southern States and the District of Columbia was 9,466,355 in 1870, and 12,577,215 in 1880, the percentage of increase during the decade being 32·9. The aggregate white population of the twenty-two Northern States in 1870 was 23,864,272, and in 1880, 30,257,557, the percentage of increase being 26·8. Then we have for the last decade, increase of whites in the North, 26·8 ; increase of whites in the South, 32·9 ; and increase of colored in the United States, 34·8 per cent. It should be observed that

the colored people have not so far surpassed the whites of the South in ratio of gain as to give any considerable encouragement to the suspicion of incorrectness in the showing of the census reports. It is as true that the Southern white population has gained slightly from foreign immigration during the decade, but it is also true, as going partly to offset this, that the colored population of the United States has gained slightly from the intermarriage of white women with colored men.

The foreign population in the South is very small compared with that in the North. The foreign-born population in Missouri is (1880) but 10¾ per cent. of the native population of the State; in Maryland, 9¾; in Texas, 7¾; in Louisiana, 6; while in Mississippi, Alabama, and South Carolina, it is about three fourths of one per cent.; in Georgia, two thirds of one per cent., and in North Carolina but one fourth of one per cent. On the contrary, the foreign-born population bears a large proportion to the native in the Northern States. In Nevada it is 70 per cent.; in Minnesota, 52; in California, 51; in Wisconsin, 44½; in Rhode Island, 39; in Massachusetts, 33; in New York, 31¼; in Michigan, 31; in Nebraska, 27; in Connecticut, 26⅓; in Colorado, 25½; in Illinois, 23½; and so on down to Indiana, the lowest, 7¾. The aggregate of foreign-born in the Northern States is 5,854,000, while in the Southern States it is only 658,000: that is, 1,011 foreigners out of 10,000 (or a little more than one out of ten) have up to the present time settled in the South. In a comparison of the white gain South and the white gain North during the last decade, the disadvantage which the former has in this element of immigration is without compensation, inasmuch as the migration from South to North is probably about equal to that from North to South, and is comparatively small at any rate. Yet the white gain South was 32·9 per cent., and North but 26·8 per cent. What, then, would be the figures after making proper allowance for the numerical effects of immigration on the population of the two sections? Only approximate results can be had.

The arrival of foreigners during the last decade is counted at 2,813,000. Deducting from this aggregate 60,000 Asiatics as non-prolific, and also other foreigners in the Territories about 65,000 more, there would remain 2,688,000 as the number belonging to the States. But these were not all counted in the census. They were here during an average of nearly five and a half years (the heaviest arrivals having taken place during the earlier years of the decade), and allowance must be made for deaths during this period. Few children or old persons emigrate. Most are in the prime of life, and the proportion of deaths would probably be allowed for at 12½ per cent. Making this reduction, there would remain 2,352,000 immigrants which were added to the population of the States during the last decade and counted in the census.

But this result may be reached by a different route—by adding the

actual gain in our foreign white population during the decade to the loss of the foreign white population which was here at the beginning of the decade. There were 979,000 more white foreigners in the States in 1880 than in 1870. According to the census of 1870, there were 5,438,000 white foreigners in the States. At 25¼ per cent. for the mortality of this class in ten years, it lost 1,373,000 during the decade. Adding this to the actual gain of foreign white population, 979,000, we get the number of immigrants during the decade, which were still surviving and counted in the census of 1880. The result is 2,352,000 —the same as by the other process. The error in this result must be comparatively inconsiderable.

Then, in order to ascertain the gain of Northern whites and of Southern whites respectively, the numerical disturbance of this foreign element must be got rid of by deducting it from the census figures of 1880; and, to this end, we must know what part of it belongs to the Northern and what to the Southern States. The South during the last decade did not receive its average quota of foreigners. In nine of the Southern States there was a falling off of foreign population amounting to 29,700. Missouri alone lost 11,000. In the other eight there was a gain of 66,000. Texas alone gained 50,000; so that, but for Texas, there would have been a loss of foreign population in the South during the decade. The foreign gain in the South, deducting Chinese, was 35,000; in the North, 944,000. Adding to the first of these numbers the foreign loss in the Southern States during the decade, 157,000, we have 192,000 foreign whites who settled in the South during the decade, and were counted in 1880. By a like process, we find the corresponding number for the Northern States to be 2,160,000. Being enabled thus to eliminate the immigration of the decade, we find the percentage of gain in the white population of the Southern States to be 30·8, and of the Northern States 17·7.

But this calculation does not bring out the relative increase of the native whites North and the native whites South. It includes all the children born of foreign parents who came to this country after the decade commenced; and this is a very considerable item. Of the foreign-born in this country, 23 per cent. are females between the ages of twenty and forty years. Of actual immigrants, it was formerly somewhat less, as it is now probably somewhat more than this. As the immigrants of the decade were here during an average of nearly five and a half years, it would be safe to reckon one living child to each immigrant female between the ages of twenty and forty, deduction having already been made for the mortality of immigrants during the decade. Making this further correction, the ratio of increase for the Northern whites would be 15·7, and for the Southern whites 30·4.

Still we have not reached the relative increase of the native whites North and South. Allowance should be made for the excess of pro-

lificacy of foreign-born mothers who came previous to the beginning of the decade. The foreigners among us have larger families than the natives of the North generally. So large a proportion of immigrants come in the prime of life, that, though the males predominate, foreigners have a larger percentage of increase than natives, even if their families were not larger. While the proportion of foreign-born white females from twenty to forty years of age was (in 1870) 23 per cent. of the entire foreign-born population, the proportion of native white females of corresponding age was not quite 13·8 per cent. of the native white population; but, of course, this great disparity is due in part to the fact that the American-born children of foreigners are counted, not with the foreigners, but with the natives. It is a fact little thought of, that the number of foreign-born white females from twenty to forty years of age is nearly one fourth of all the white females of that age in the United States. In 1870 the number of native white females of this age in the whole country was 3,867,617, and of the foreign 1,260,965, the latter being 24·6 per cent. of the whole. How is it for the Northern States alone?

It is deducible, from the report of 1870, that the foreign-born females in the North, between the ages of twenty and forty years, numbered 1,119,000, while the native-born white females of like age in the same States numbered 2,532,000, the foreign being 30·6 per cent. of the whole. A similar calculation shows that in the South the proportion of foreign-born in the period of motherhood was but 9·6 per cent. Granted an excess of prolificacy in our foreign families over the native, the advantage thereof to the rate of increase accrues wholly to the North. It is not probable that foreigners in this country are any more prolific than, or, indeed, quite as prolific as, the native Southern whites.

On the admission of greater prolificacy in immigrants generally than in Northern natives, the points to be met are so numerous that any arithmetical statement of them would be rather complicated and tedious. We let that pass with the statement of an assured belief that, if proper allowance were made for this element of the problem, the ratio of increase in the native white population of the North would be shown to be very little, if any, above 12 per cent. But we omit this. The comparative rate of increase may then be recapitulated as follows: Native whites North, 15·7 per cent.; whites South, 30·4 per cent.; colored in the United States (allowing 1·5 per cent. for error in census of 1870), 33·3 per cent.

I am aware that the division-line assumed in this statement between the North and South is quite arbitrary, and that where the border States meet there is comparatively little divergence in the characteristics referred to; but some such line had to be assumed to bring out the lesson of this study, and that which has been used probably involves as little disturbance of results as any.

In a comparison of the white and colored increase, the side of color has no offset equivalent to the advantage of immigration for the other side. The only thing in the form of such offset is marrying across the color-line, already referred to. When a white woman marries a colored man, she virtually migrates as a wife and mother, and her children and descendants for ever after count on the colored side. This is taking place to a certain extent—to a very limited extent, it is true; but, as small a matter statistically as it appears to be, the census should put it on record for comparison hereafter. Native children of foreign parentage are designated, and colored children of white mothers should also be designated. The prejudice is at present very strong against such unions; but that prejudice may gradually weaken, and cases of the kind may multiply. This tendency is worthy of note for its significance on the future psychology of the American people. If to the rapid multiplication of the colored population is to be added an accession through white motherhood, the increase of the colored over the white must be accelerated, unless prevented by counteracting influences not at present in existence. And, when in this connection we contemplate the increasingly slow multiplication of the people of highest civilization in our country, the prospect for the future is not an optimistic one.

Very great subjects can only be touched upon, not treated, here. Why is it that the native whites of the North are multiplying so much more slowly, not only than the colored, but even than the Southern whites? Simply because of the possession of greater wealth and culture. It was different early in the century, when the descendants of the Puritans and Dutch stood on a "lower" grade in the struggle of life. Families were larger then. The possession of wealth and education is a surer check on population than the famous "positive checks" of Malthus—"wars, plagues, and famine." They are surer and greater, because they act without intermission. I do not shrink from stating the fact, unpleasant as it may be. I am aware that Knox, Clibborne, Schade, Kapp, and others, refer the slow increase of American natives—they do not discriminate between Northern and Southern—to the effects on the European stock of an uncongenial climate. This is an *a priori* fancy which is entitled to no particular consideration, since it is as wholly without support as that other *a priori* fancy, that the descendants of Europeans in this country are gradually turning into a sort of red Indians.

There is, perhaps, no law of human history better assured than this: that, with high civilization and the long enjoyment of wealth, culture, and the luxury and dissipation which are sure to accompany them, population increases more slowly, in time to become stationary, and at last decline and succumb to younger and more vigorous peoples, who have been hardened in the conflicts of poverty and rough fare. Roscher, the German economist, states this profound truth:

"As a rule, the influences which have accelerated a nation's progress and brought it to the apogee of its social existence end in precipitating its ruin by their further action. Every direction which humanity takes has almost always something of evil in it—is limited in its very nature, and can not stand its extreme consequences. All earthly existence bears in itself, from the first, the germs of its decay." It would not be difficult to point to the springs of human action which must render this necessary, except on the presumption of a revolution in human nature itself, an event not likely to occur.

It is not always the highest that prevail, especially in the conflicts of industry. It is the plodding, the hardy—those who have few wants and can do with little. This is well understood by the industrial classes who have come into conflict with the Chinese in this country and in Australia. And it is plain that a hardy race with moderate wants, which increases twice as fast as a higher race in the same territory, will contribute more and more to the psychological and social status of the whole people. There is nothing surer than that the high-toned Yankee is losing in his relative weight of numbers in this country, and it is equally sure that he will lose more and more, and eventually be absorbed. The German, the Celt, the Southerner, the colored, are all gaining upon him. Some patriotic people deplore the incoming and rapid multiplication of white foreigners in the North; and yet it is this very accession of Caucasian strength that affords the best ground of hope for the psychological elevation of the great American type or types which are yet to take definite form. If only Yankees were contending with the colored for supremacy, it would go far worse with the whites than it now does in the race of numbers. Allowing the increase of the colored to be 33⅓ per cent. in ten years, they would double four times in less than a century; that is, the census of 1980 would show their numbers to have increased from 6,577,000 to 117,000,000! Taking the increase of the Northern whites to be 15·7, as it is shown to be for the last decade, after eliminating the obvious augmentation due to immigration, their numbers would only double while the colored quadrupled; and the census of 1980 would show that the native whites of the North had increased from 24,403,000 to 105,000,000. That is, the colored race of the United States would then outnumber the descendants of the present native Northern whites by 12,000,000. It is, of course, not to be expected that these ratios of increase would be maintained for that period: both would fall, and both fall, perhaps, in about the same proportion; and this will probably take place, notwithstanding the accession of white mothers to the colored stock and the infusion of foreign blood into the veins of native whites. If these and the colored were the only contestants on American soil, the despised race would make comparatively short work of it, and come to be the prevailing people. As it is, however, with rapid increase of whites at the South, and white immigrants pouring into the country,

the problem is a very different one. But it is still true that at last, at however remote a period, the industrious, hardy, plodding, persistent, breeding race is that which will push its way into predominance. What race will be our Macedonian, our barbarian, or our Turk, can not be divined. It may still be in embryo. The conflict of races is now less on the bloody fields of battle than on the peaceful fields of industry, and other than martial traits of character may hereafter determine who shall be the victors. Formerly the conquerors came from without; hereafter they may spring up within.

In the world's history peoples have risen, flourished, and declined. How or even where they came into existence is not always known; but this we do know, that they came into prominence only by complying with the conditions of ethnical consequence. They were hardy, aggressive, and prolific. And there is this paradox, that the greater they became the surer were they to perish. Greek and Roman belong to the irrevocable past; and many who helped supplant them have yielded in turn to others. The Vandals came like a vision into history and then disappeared. The Thracians, a numerous people in the Eastern Empire during the first century, have long since become extinct. The Vallacians, from small beginnings in the eleventh century, forced their way into history and in two or three centuries passed out of sight. The Ottoman Turks, a small nomadic tribe of Mesopotamia—temperate, hardy, warlike, pushing—rapidly grew into a great historical people, and made a place for themselves where Christians and Greeks once held sway; but they have long since entered on the period of their decline, and eventually some more vigorous people will take their place. If we could know the origin of the vast Teuton family, we should, no doubt, be astonished at its then small promise of future greatness. The Slav is pushing his way into consequence, and we can not appoint the limit of his capabilities. It sometimes takes an obscure race but a little while to rise. This we may study even in our own times. What we know as the Celtic Irish were, only two hundred years ago, less than one million strong; now they number many millions and are increasing with great rapidity. They are not afraid of hardships, and their vices are not of the effeminate kinds which undermine the constitution. They are finding homes in many lands, and who can forecast their destiny? We have a still more recent instance in the colored people of the United States. Eighty years ago they numbered only 1,002,000, but with all their drawbacks they are now 6,577,000. With a like increase for the next eighty years, they would be 43,000,000 strong. Even less do we know of what is in store for this race than for almost any other. The situation is unique, and there is little clear history to guide us; while it is far less likely than any of the white varieties to disappear in the universal blending of races on American soil.

PROGRESS OF HIGHER SCIENCE-TEACHING.

By W. H. STONE,

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IT is doubtful whether the generality of well-educated men fully appreciate the great, the radical, and the almost revolutionary change which has in the past thirty or forty years come over the scope and spirit of English liberal education. Indeed, it can hardly be termed a change; but might be more correctly designated as a substitution of one branch of human knowledge for another. For, whereas, in the first forty years of the present century, the dead languages, especially Latin and Greek, history, logic, and metaphysics, fairly held their own against the computative sciences of mathematics, mechanics, physics, and chemistry, and the systematic or classificatory subjects of botany, geology, and zoölogy as topics of teaching and examination, they seem at the end of the second forty to have been all but superseded. No doubt in the main the revolution, great as it undoubtedly is, has proved salutary. Englishmen, with their characteristic tenacity of existing forms, had retained all but unchanged in their large public schools and in the older universities a form of intellectual culture which really originated in the middle ages, or at the latest with the restoration of learning. This is no mere figure of speech. The writer of the present remarks took his first childish lessons, after mastering the rudimentary arts of reading and writing, from "The Boke of Roger Ascham," and received his first rewards for saying, parrot-like by rote, the ancient farragos now only known by their initial words—"*Propria quæ maribus*," "*Quæ genus*," and "*As in præsenti*." Of the present generation, not one in a thousand has ever even heard of these mediæval *aide-mémoires*, or of the somewhat more useful scholastic scheme of syllogisms, beginning with the cabalistic formula, "Barbara Celarent." Later on, he and his companions were expected weekly to manufacture, *nolentes volentes*, a certain quantity of poetry! —God save the mark!—in the Latin and Greek tongues. He can well remember his father's remonstrance on finding him working at "that nasty chemistry, when you have not done your Latin verses." Perhaps the most singular travesty of teaching was the inculcation of that laboriously useless heap of conflicting rules termed the "Greek accents." It was well known to every scholar that they were non-existent in classical times; that they were probably prosodiacal; that they sprang up about the time when Greek was going out of use as a spoken language; and that, except in very few instances, they now served no purpose whatever. In spite of this, they were steadily and perseveringly thrust down the throats of schoolboys, insomuch that

ignorance of the hideous pedantry of a mediæval grammarian might involve the pain and humiliation of corporal punishment.

That all, or most, of this has been swept away is ground for unmixed satisfaction. But it does not absolutely follow that what is being substituted for it is beyond comment or improvement. There may be errors and pedantries developing in the new as in the older system. Nor are they difficult to point out.

The teaching of science has tended to give an impulse to the computative, to the disadvantage of the judicial and appreciative functions of students' minds. Indeed, the computative faculty, so highly developed at times in men not otherwise liberally educated, is not the widest in intellectual scope, nor the fittest preparation for some branches of life-work. Men in after-life are called upon to use their imaginative powers, to sift evidence, and to weigh symptoms, as well as to solve problems. They may adopt artistic or literary pursuits, they may choose the professions of law or of medicine. In all these, the attempt to reduce the subject-matter laid before them to the strict conditions of an equation or a ratio, so far from being a fruitful mental effort, may absolutely prove a hindrance. There is a common type of mind which fails to see a proof which is not of the character of demonstration, and which, in its absence, neglects to use the faculty of judgment and decision so necessary in the common affairs of business.

The computing school, and especially those who teach its physical branches, very correctly and consistently insist upon the solving of problems as a test of thorough knowledge. Mr. Day, whose work appears to be mainly performed "in the laboratory of King's College, under the direction of Professor Adams," in an excellent collection of questions upon electrical measurement, says, "It is now universally admitted that numerical exercises are necessary in the study of the experimental sciences, both as giving practice in the application of the various theories, and as affording tests of ability to comprehend as well as to apply that which has been learned."

It must be remembered, however, that, even among advanced and professed mathematicians, the faculty of solving problems is very unequally distributed—a fact which is openly recognized at the great mathematical University of Cambridge. The problems themselves are often open to comment, as partaking of the nature of enigmas, or riddles, rather than as fair tests of knowledge. Like riddles, moreover, they exercise a kind of fascination on their concocters, and are very liable to figure in papers of questions. The writer, for instance, has seen in a paper on physics a question which involved an indeterminate equation, and of which the solutions were infinite in number. Surely this should have been relegated to its kindred algebra. But an instance which has occurred within the present year is so exceptional as to deserve quotation. It was a pass, not an honors paper,

set for matriculation—the primary and initial step of the whole university career; a gate to further knowledge, which should be prudently left as wide open as is consistent with a reasonably high standard. The paper consisted in all of sixteen questions, and is therefore too long for quotation in full. Of these, says the heading—

"*Not more than eight questions are to be answered, of which at least two must be selected from Section A.*

A.

"1. State your reason for regarding a pound as a unit of mass and not of force. What is the most convenient unit of force when a foot, a pound, and a second are units of length, mass, and time, respectively?

"2. State the conditions necessary for the equilibrium of a body free to move in one plane. To what do these conditions reduce when one point in the body is fixed?

"3. A solid right circular cone of homogeneous iron is 64 inches in height, and its mass is 8,192 pounds. The cone is cut by a plane perpendicular to the axis, so that the mass of the small cone removed is 686 pounds. Find the height of the center of gravity of the truncated portion remaining, above the base of the cone.

"4. A heavy body starting from rest slides down a smooth plane inclined 30° to the horizon. How many seconds will it occupy in sliding 240 feet down the plane, and what will be its velocity after traversing this distance? [$g = 32$.]

"5. What is the 'kinetic energy' of a moving mechanical system? A shot of 1,000 pounds moving at 1,600 feet per second strikes a fixed target. How far will the shot penetrate the target exerting upon it an average pressure equal to the weight of 12,000 tons?"

If it be borne in mind that judgment on the five momentous mathematical generalizations (for they are hardly within the pale of physics proper) was demanded of boys averaging sixteen or seventeen years of age, fresh from school, it will be evident that the race of schoolmen and of De Morgan's "Conundrum"-makers is not yet extinct, and that the current rumor of the award having been returned to the examiners for mitigation may have some foundation in truth.

It is interesting to note how this radical change in the scope and subjects of education has reacted on our older and on the more recently founded universities. Far in the van stands that of Cambridge. Here, from the traditional character of the instruction given, little modification was required to bring modern requirements into harmony with the older teaching. Ever since the appointment of the great author of the "Principia," the discoverer of the binomial theorem, and of the "Fluxionary Calculus" to a junior fellowship in Trinity Col-

lege, A. D. 1667, physics and mathematics have had their full and abundant share in the curriculum of this university. If, therefore, there has been a greater leaning toward physics and applied, as distinguished from pure mathematics, it has been accomplished, almost unperceived, under the guidance of men like Stokes, Thomson, Clerk-Maxwell, and his successor, Lord Rayleigh, who combine the highest powers of numerical analysis with the imaginative, constructive, and inventive faculty of Wheatstone and Faraday.

At the sister University of Oxford the case is very different. Here the method of the schoolmen and the misrepresented teaching of Aristotle reigned supreme until our own time. The anachronism was indeed expressed in concrete form by a single word. The "science" which up to 1852 formed one foot of the tripod, with scholarship and history, on which honors were adjudged, was the science of a thousand years before, the metaphysics and moral philosophy of the Stoics—of those who, proposing to teach it, wrote over the entrance to their school, *οὔδεις ἀγεομετρήτος εἴσιτο*, which, in the terms we are now using, may fairly be translated, "Let none unacquainted with physics enter." It was a purely mental analysis of the great problems even then seen to underlie our simplest conceptions of the universe. The change required in this center of learning was therefore from metaphysics to physics; it was a scientific putting of the cart before the horse; a substitution of Pythagoras or Archimedes for Plato or Aristotle, as the latter then and there were studied; namely, in his dogmatic treatises on ethics, politics, rhetoric, and metaphysics, and not in his far stronger genius as a natural historian and zoölogist.

Is it to be wondered that the wrench thus suddenly given produced molecular change; that the impulse overran the neutral point; and that those who previously had been commended for accurate knowledge of the metaphysical attributes of God should require time to learn the internal economy of a Holothurian, the exact chemical constitution of ethylic-diethyloxamate, or the formula for Carnot's reversible heat-engine? Even now, within an ace of thirty years from this intellectual cataclysm, poor old Oxford is only just recovering from a protracted state of vertigo, and settling down again to useful work. It is sad that she should have to chronicle the early loss of one who has been a main agent in the revolution. The Linacre Professor of Physiology [Dr. Rolleston], who began as an orthodox first-classman in the school of *Litteræ Humaniores* in 1850, dies in 1881 at the age of fifty-two, an advanced exponent of modern views in anthropology. —*Popular Science Review.*

THE AUSTRALIAN ABORIGINES.

By GABRIEL MARCEL.

THE recent work by Mr. Brough Smyth relative to the aborigines of the colony of Victoria contains also many curious details respecting the manners and customs of the natives of other parts of Australia. It is evident that the native race is not everywhere equally pure. In the northern part of the continent traces may be observed of immigrations in earlier times of Papuans from New Guinea; of Chinese, whose visits are attested by the lacquered articles, cotton cloths, bamboos, etc., which have been found in the hands of the natives; and of the Malays, who have frequented the northwest coasts for fishing from time immemorial. Nevertheless, the figures of the natives, their arms, their workmanship, have everywhere a strikingly uniform character. Their numbers have fallen off very fast in the face of the extension of the white settlements, partly on account of the fierce wars that have prevailed between them and the colonists, but more in consequence of the inroads of the vices and maladies which they have contracted from the whites. The missionaries have been able to make but small headway in their efforts to convert them, and have exerted no appreciable effect in staying the progress of extermination. Recently the Government has established a bureau for their protection, has allotted lands to them, and opened schools for them, and the few of them that are left enjoy at least a promise of better times.

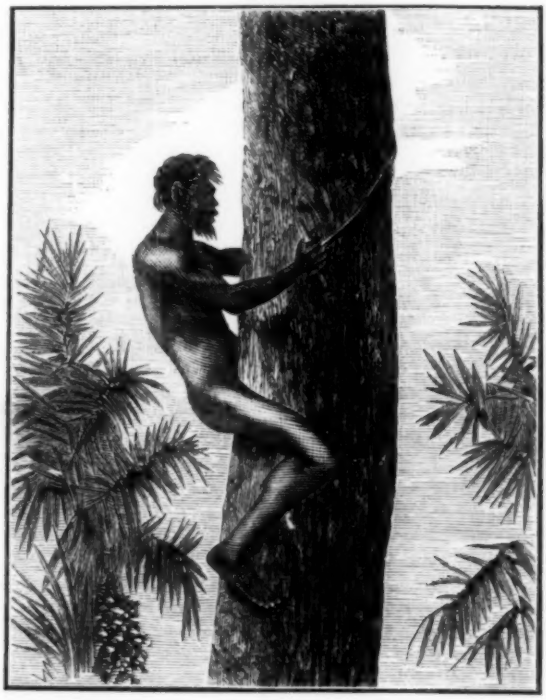
The disappearance of the Australian race has been promoted by certain peculiarities of its own, among which are the belief that no person can die a natural death, and the general practice of infanticide. When a member of a family is about to die, the natives believe it is the result of witchcraft practiced by some neighboring tribe. The relatives of the deceased arm themselves at once, and follow the course that is taken by the first insect or fly that they see light upon the grave of the deceased. It is not from any lack of affection that the mother kills her child, but most frequently because it is impossible to give it food, or because it cries too much, or is stupid, or deformed, or weak; and, along with this incomprehensible hardness of heart, these savages give to their children numerous marks of affection. The same man who will half kill a girl to make her his wife will protect her and love her tenderly after she has submitted to his will. The part of the wife is far from being agreeable. The slave of her husband, she has to carry, besides her child, all the burdens when they travel, to do the hard work, and be ready at any moment to obey the orders of her

Fig. 1.

lord. He is brutal, and punishes the lightest offense with the lance or hatchet.

Polygamy is universal, but the oldest men of the tribe have the most wives, acquiring them in exchange for their daughters. A number of young men are thus compelled to remain bachelors. When a young man has, after cruel ceremonies and horrible tortures to test his courage, been proclaimed a warrior, he may take a wife. If he is a son of a great warrior, he will have little difficulty in the matter; but, generally, he will have to capture his wife, or buy her from a neighboring tribe, in return for some girl over whom he can exercise a certain degree of control. Since the tribe is only an extension of the family, and all of its members are generally closely related, it is necessary to marry outside of it. Hence three methods of marriage are practiced—free consent, capture, and exchange.

FIG. 2.



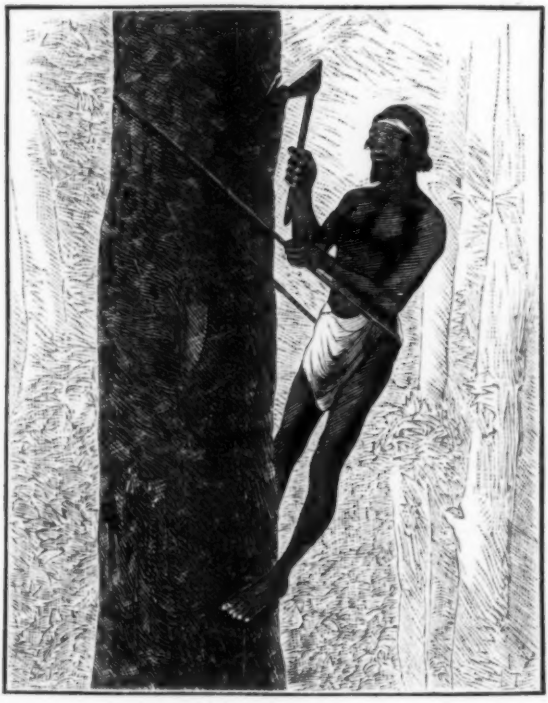
Mutilations, especially of the first phalanges of the left hand, are practiced among the natives; circumcision, tattooing—not regular and complete as in Samoa and New Zealand, but simply in curved lines—are in frequent use. They paint themselves indifferently with white, yellow, and black streaks; blue was unknown among them till the arrival of the Europeans.

The most numerous and most robust tribes are those which live on

the borders of the sea or the rivers, where they are sure of enough food. The tribes of the interior, where water is extremely scarce, are miserable, repulsive, and feeble, their encampments are more primitive, their arms are less well cared for, their dialect is ruder, than among the inhabitants of the coast.

It has been represented that these natives have not the virtue of providence; but they know how to make provision for a bad season. Grey affirms that they save the nuts of the zamia, and Coxen describes the methods which the natives of the northeast employ for preserving oily seeds, gums, and other kinds of food. Whenever a whale or a large fish is stranded on the shore, fires are kindled, and all the families around assemble to get a share of the windfall.

FIG. 3.



Families settling down choose a situation near a forest where they can get the wood they need for their cabins, which are sometimes made of limbs covered with earth, sometimes of the bark of a tree called the stringy-bark. This bark, according to Baron de Bougainville, is very thick and incombustible; it serves both for the walls of the cabins and their roofs, and, as it can be taken off in large slabs, only a few hours are needed to make with it a habitation which gives a perfect shelter. When a savage has found a tree suitable for his purpose, he, with his stone hatchet (*kal baling-carek*, Fig. 1), cuts a

notch in the bark for his great-toe, raises himself up, makes a second toe-hole, and climbs up with a facility, rapidity, and skill, of which we can hardly have an idea. In Western Australia, the helve of the hatchet is pointed, and the natives, after making the notch, stick the tool in the bark and lift themselves up with it. In other parts, they scale very large trees with the assistance of a simple cord of vegetable fiber having wooden handles at its ends (Fig. 2). Sometimes the cord is passed around the tree and the climber, so as to hold him up by his loins. The man hugs the tree with his legs, lifts the rope, draws himself up without slipping back, and reaches the desired height in a very short time (Fig. 3).

For making their canoes the natives choose the bark of certain gum-trees. The species most in favor for this purpose is the red-gum

FIG. 4.

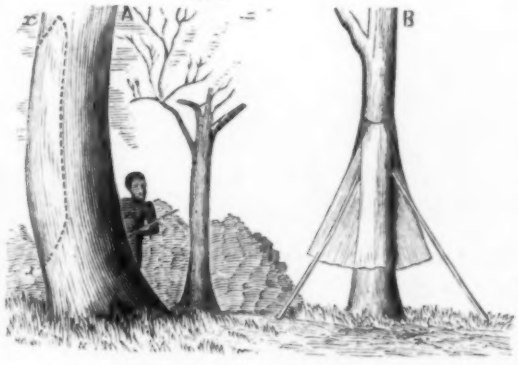


FIG. 5.

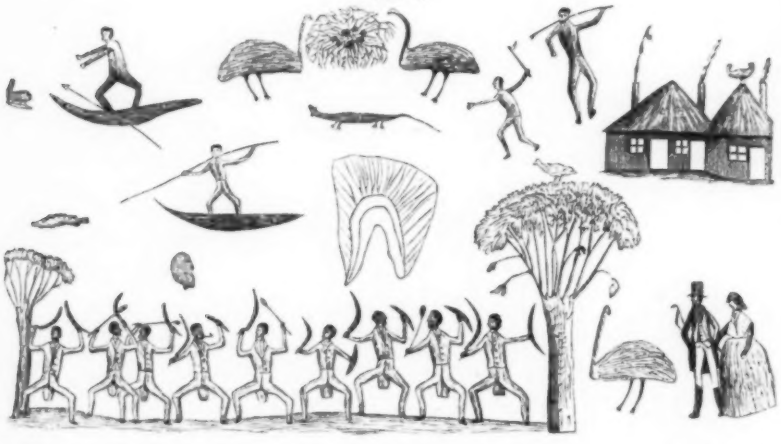
(*Eucalyptus rostrata*), from which the bark can be peeled in large pieces. It is considered desirable to get the bark from a tree that is a little bent, so that it shall be somewhat near the shape of the canoe, and a part of the labor of making the vessel may be saved. The bark is cut according to a specially designed shape, at the points x and x' (Fig. 4, A), and these points are connected by cuts from one to the other. The bark is then gradually peeled off by the aid of the helve of the hatchet and a stick (Fig. 3). Sometimes two sections are made at three and at ten feet above the ground, and connected with a vertical cut (Fig. 4, B). Poles are then introduced between the tree and the bark so as to work out a gradual detachment of the latter. The slab of bark is then given the desired form, and the ends are drawn together with cords or withes. This is one of the most primitive canoes that can be imagined.

These people appear to have a really genial taste for design. Freycinet relates that Captain King found on the walls and the floors of the caves in Clark Island numerous drawings executed with a white earth upon a reddish ground with which the rocks had been covered. Finders discovered similar sketches in a little island in the Gulf of

Carpentaria, representing porpoises, turtles, kangaroos, and a human hand (Fig. 5). At another place in the cave was a figure of a kangaroo followed by thirty-two hunters.

The atlas of the "Voyage of Perron" contains copies of a number of designs by natives of Port Jackson, but none of them are more curious than the one which we reproduce from Mr. Brough Smyth (Fig. 6).

FIG. 6.



Above are a hunter chasing a swan on the water, two emus with their nest and eggs, a native about to strike a large lizard, and two European houses; below, are nine natives dressed in European clothes, holding native arms in their hands, and executing a war-dance; while in the right-hand corner are an emu, and an Englishman, who, with a whip sticking out from his pocket and wearing hunting-boots, gives his arm to a woman whose ample crinoline fairly indicates the time when the figures were drawn.

These first essays of a barbarous race possess a high interest, and cause us to regret that the circumstances controlling the condition of the people have not permitted them to give their tastes a higher development.—*Translated from La Nature.*

UNEXPLORED PARTS OF THE OLD WORLD.

BY M. VÉNUKOFF.

I PROPOSE to point out very briefly certain regions of Europe and Asia which have not yet been explored. Some persons may be surprised to hear Europe spoken of in this sense, but there are considerable parts of that continent of which much of interest is yet to be learned, and concerning which our maps are inexact and our geography

is still defective. Extensive geodetic and topographical surveys were made in the principality of Bulgaria and Eastern Roumelia during the war of 1877–'78, but that the geography of Macedonia, Epirus, and Thessaly is far from being exact is proved by the difficulties which were experienced at the Conference of Berlin in defining the boundary between Turkey and Greece. In Russia all the northern provinces, from the frontier of Norway to the Ural Mountains, have been explored only superficially, and the only well-traced lines are those of the coasts and of the beds of the great rivers. The map of Lapland is equally imperfect, the great *tundra* of the Samoieds is wholly unexplored, and but little is known of the northern part of the Ural Mountains, which is probably equally rich in minerals with the middle division of the chain. From the Ural we pass to Nova Zembla, of which the littoral only has so far been examined, but which is destined to afford geologists an interesting study concerning its probable connection with that chain and with the archipelago of Franz-Joseph Land.

The parts of Asia bordering on the Kara Sea and the Arctic Ocean offer many points worthy of the attention of explorers. Among them is the enormous tract belonging to the basins of the Khatanga and Anabara, a country twice as large as France, concerning the geography of which the voyages of Tchékanovsky and Nordenskjöld have upset our old ideas, and which are still only hypothetically represented on our maps. The countries east of the Lena are wholly unknown, and embrace very extensive regions that have never been visited by Europeans. Wrangell has made a sketch of them from information supplied by Siberian natives, but it can not be depended upon. The country of the Tchouktchis is superficially well known, thanks to the labors of Nordenskjöld and previous explorers, but has never been scientifically examined. The extreme northeast peninsula north of the Gulf of Anadir needs a thorough exploration of its interior, for it may become important as a station for whalers, particularly if it should be found to contain coal. The country of the Koriaks, a vast desert region of hardly accessible mountains, traversed by no important river, offers few attractions, but might be made to yield a rich harvest of new discoveries to the naturalist. Kamchatka is better known, but it needs an accurate survey. The geologist would find objects of interest in its central chain of mountains and its active volcanoes; the botanist and zoölogist, in its rich flora and fauna; the landscape-painter, in its majestic peaks with their summits vomiting fire and their slopes covered with magnificent forests; the ethnologist, in tracing the connection between the native population and the people of the Kurile Islands on the one side and of Northwestern America on the other, and in watching the development of a new mixed race, which has originated since the Russians have settled in the country. On the other side of the Sea of Okhotsk we find awaiting a competent explorer the northern

part of Saghalien, an island as large as Ireland; the mountain-chain which rises between the Strait of Tartary and the valleys of the Amoor and Ousouri; the vast spaces of Manchooria; the mountains dividing Corea from China, covered with great forests, and containing so considerable mineral wealth as to afford a profit to the Chinese vagabonds who work for it with the most primitive processes; and the forbidden land of Corea. On the classic ground of the Celestial Empire are spaces larger than Great Britain that may be ranked among unknown lands. Eastern and northern Thibet, the least accessible part of all the empire, presents in particular many interesting problems, the most important of which is that of the river systems. What is the true relation between the rivers which we see hypothetically represented on the map of Thibet and those of Indo-China and India? Is the chain of the Kuen-Lung, which appears on the maps as one of the principal ranges of the continent, really worthy to be ranked with the Himalaya and the Thian-Shan systems? The latter question is now complicated with some apparently contradictory circumstances. The southern part of eastern Turkistan deserves the attention of explorers equally with Thibet. It is the most inaccessible desert of the continent, a land of jade-stone and gold, of camels and the wild horses that are not known anywhere else in the world.

Prejévalsky, during his last expedition, touched a country of quite exceptional geographical interest, the sources of the Hoang-Ho. He was not able to penetrate to the "Sea of Stars" itself, but he saw a considerable part of the narrow valley by which the upper Yellow River flows toward the east. Access to the sources themselves of this great stream has thus become one of the geographical *desiderata;* but no doubt exists concerning the absence of the subterranean connection between the Hoang-Ho and the Tarim, of which the Chinese geographers have often spoken.

The great desert of Gobi has lately been tolerably well explored, but the question is still to be answered whether it is crossed by a chain of mountains connecting the eastern end of the Thian-Shan with the In-shan. The mountains, if they exist, can not be very high, for no large rivers flow from the region, and some streams flow toward it; but they are marked on several maps of China, including that of the Russian staff; and the existence of a direct route between Koukou-Khota and Barkoul indicates that there are springs along the line, and they must have hills to maintain them.

Northern and northeastern Mongolia have been topographically delineated with some exactness, but no naturalist has visited them; and only three or four European travelers have crossed the Kingan range between Mongolia and Manchooria, whose geological structure and mineral, zoölogical, and botanical riches have still to be found out.

Returning along this range into China proper, we enter a country the superficial character of which has been often described, but con-

cerning which the determinations are still very inexact. Consequently, our maps of China are filled with chains of hypothetical mountains, which certain famous *savants* would like to impose upon us as the last word of modern science. Unfortunately for them, Nature has the bad habit of not agreeing with systems that are too learned, even when they are framed by disciples of the most eminent geographers. Anthropological interest is attached to the heterogeneous populations of the western provinces of this vast country, and we may possibly find among them the missing links of the chain that may connect the yellow race with the white race. To make such researches successful, one must of course be an accomplished scholar in Oriental linguistics and philosophy, but the possible results of such investigations are so attractive that I am disposed to believe in their near realization. Similar anthropological and linguistic researches may be undertaken in the southwestern provinces of China, which are filled with aborigines not of Chinese origin ; and hence we may go to Indo-China, the richest part of Asia, of which only the French and the English colonies, the coast regions, and the largest valleys are known, and where the origin of immense rivers is still to be traced.

Japan and the archipelagoes of the Pacific are others among the richest countries, and have attracted much attention from travelers ; but what has been learned about them should only sharpen the desire to learn the more which is still unknown ; and these islands, with their varied populations, afford most profitable studies in language and anthropology.

British India is the best explored part of Asia, and is even better known than some parts of Europe. It does not come within our category ; but the adjoining countries of Afghanistan and Beloochistan still await a scientific exploration of their most important parts. Our geographical knowledge of the Southern parts of Turkistan is also wanting in many points concerning which it would be desirable to know more. The Oasis of Merv, which is so often mentioned in the journals, has never been visited by a scientific traveler. The fundamental question of Turkoman geography is identified with the discovery of the ancient beds of the Oxus and its affluents. Many important advances have been already made in this direction, but much of the desert stretching between the present Amoo-Darya and the mountains of Khorassan still remains to be explored ; and on its competent exploration depends much that is important to the improvement of the country.

Great progress has been made in the last twenty-five years in the exploration of Khorassan, and Stebnitzky's late map of Persia is quite full in relation to that province. Western Persia has been nearly as well mapped, but much is yet to be done concerning the southern part and the interior of the country. The greater part of the interior, however, has been known, from the most remote antiquity, to be a desert,

and is not likely to afford any features of important interest. The same is the case, in a higher degree, with the most of Arabia, which the inhabitants themselves say God created in anger, and which the travels of Palgrave and Blunt show is not likely to afford enough scientific results to pay for the toil and dangers of a thorough examination. Our knowledge of Mesopotamia and Syria is being rapidly increased by the zeal of antiquarian explorers, whose investigations, although they are rather historical than geographical, and concern the past rather than the present, are not without results of contemporary interest. In Asia Minor and Armenia, researches already carried on need to be completed and systematized and made generally applicable to the whole country; and there are spots within three or four days' journey from Constantinople that still need to be thoroughly worked out.

We are back in Turkey, whence we started, but on the southern instead of the northern side of the Hellespont and Bosporus. We might complete our tour by examining these straits, and finding whether they are traversed by a single current, carrying the waters of the Black Sea into the Mediterranean, or by two currents, one superficial and running to the west, the other submarine and directed toward the east—a question that may have a bearing on the future of the countries east of the Black Sea.—*Revue Scientifique.*

WHAT IS A MOLECULE?

MODERN science declares that every substance consists of an aggregation of extremely small particles, which are called molecules. Thus, if we conceive a drop of water magnified to the size of the earth, each molecule being magnified to the same extent, it would exhibit a structure about as coarse-grained as shot; and these particles represent real masses of matter, which, however, are incapable of further subdivision without decomposition. A lump of sugar, crushed to the finest powder, retains its qualities; dissolved in water, the mass is divided into its molecules, which are still particles of sugar, though they are far too small to be seen by the highest powers of the microscope. The physical subdivision of every body is limited by the dimensions of its molecules; but the chemist can carry the process further. He "decomposes," or breaks up, these molecules into "atoms"; but the parts thus obtained have no longer the qualities of the original substance. Hence the molecule may be considered as the smallest particle of a substance in which its qualities inhere; and every molecule, though physically indivisible, can be broken up chemically into atoms, which are themselves the molecules of other and elementary bodies.

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No one has ever seen or handled a single molecule, and molecular science therefore deals with things invisible and imperceptible by our senses. We can not magnify a drop of water sufficiently to see its structure; and the theory that matter is built up of molecules depends, like the philosophy of every science, on its competence to explain observed facts. These are of two kinds—namely, physical and chemical. A physical change in the condition of a body is illustrated by dissolving a lump of sugar in water. The sugar disappears, but remains present in the water, from which it may be recovered by evaporation. But if we burn the lump, we effect a chemical change in its condition. The sugar again disappears, and in its place we get two other substances—namely, carbon and water.

Similarly, water is converted by boiling into the invisible vapor, steam; but the change in its condition is physical only, for the steam condenses to water on being cooled. If, however, we pass water through a red-hot iron tube, it disappears, and is replaced by the two gases, oxygen and hydrogen. In the latter case, the liquid suffers a chemical change, or, as we say, is "decomposed" into its constituent elements. Those changes, therefore, which bodies undergo without alteration of substance are called physical; while those which are accompanied by alteration of substance are called chemical.

Turning our attention first to the physical side of the question, let us inquire how far some of the fundamental laws of science are illustrated by the molecular hypothesis. Among the most important of these is the law of Boyle, which declares that the pressure of gases is proportional to their density. The theory under review is based at present on the phenomena of gases, and considers these as aggregations of molecules in constant motion. Their movements are supposed to take place in straight lines, the molecules hurrying to and fro across the containing vessel, striking its sides, or coming into contact with their neighbors, and rebounding after every collision, like a swarm of bees in a hive flying hither and thither in all directions.

We know that air, or any gas, confined in a vessel, presses against its sides, and against the surface of any body placed within it. This pressure is due to the impact of the flying molecules; and the constant succession of their strokes is, according to this theory, the sole cause of what is called the pressure of air and other gases. As each molecule strikes the side of the vessel the same number of times, and with an impulse of the same magnitude, the pressure in a vessel of given size must be proportionate to the number of molecules—that is, to the quantity of gas in it; and this is a complete explanation of Boyle's law. Let us next suppose that the velocity of the molecules is increased. Then each molecule will strike the side of the containing vessel not only more times per second, but with greater force. Now, an increase in the velocity of the molecules corresponds in theory to a rise of temperature; and in this way we can explain the increase of

pressure, and the proportions of such increase which result from heating a gas. Similarly, Charles's important law, that the volume of a given mass of gas under a constant pressure varies directly as its temperature, follows obviously from the hypothesis.

Priestley was the first to remark that gases diffuse through each other. This fact is familiarly illustrated by the passage of odorous gases through the atmosphere. If a bottle of ether is opened in a room, its vapor diffuses through the air, and its presence is soon recognized by the sense of smell. In this case, the ether-molecules may be figured as issuing from the bottle with great velocity; and, if their course were not interrupted by striking against the molecules of the air, the room would be instantaneously permeated by their odor. But the molecular particles of both air and ether are so inconceivably numerous, that they can not avoid striking one another frequently in their flight. Every time a collision occurs between two molecules, the paths of both are changed; and the course of each is so continually altered that it is a long time in making any great progress from the point at which it set out, notwithstanding its great velocity.

We must next inquire how these velocities are measured, and what is their amount. We have seen that the pressure exerted by a gas is due to what may be appropriately called the molecular bombardment of the walls of its containing vessel; and, knowing this pressure, we can calculate the velocity of the projectiles, if we can ascertain their weight, just as we can estimate the speed of a bullet when its weight and mechanical effect are known. Now, a cubic centimetre of hydrogen at a pressure of one atmosphere weighs about one thousandth part of a gramme; we have, therefore, to find at what rate this mass must move—whether altogether or in separate molecules makes no difference—to produce this pressure on the sides of a cubic centimetre. The result gives six thousand feet per second as the velocity of the molecule of hydrogen, while in other gases the speed is much less.

The question of molecular weights brings us face to face with the chemical aspect of the hypothesis; and we have now to examine the support which is given to it by chemical phenomena, and show how wonderfully these are correlated with the physical proofs. Bearing in mind the distinction between physical and chemical changes, we know that we can make a mixture of finely divided sulphur and iron, for example, in any proportion. But these bodies when heated combine chemically to form a new substance called sulphide of iron; and the two classes of products exhibit great differences, which are indicated by a most remarkable characteristic. Chemical combination, unlike mechanical mixture, always takes place in certain definite proportions. Thus, fifty-six grains of iron combine with exactly thirty-two grains of sulphur; and, if there is any excess of either substance, it remains uncombined. This principle is known as the law of definite combining proportions, and the atomic theory, which, in one shape or an-

other, is as old as philosophy, was first applied to its explanation by the English chemist Dalton in 1807. He suggested that the ultimate particles of matter, or atoms between which union is assumed to take place, have a definite weight; in other words, that they are distinct masses of matter. In the combination of the two elements in question, therefore, an atom of iron unites with an atom of sulphur to form a molecule of sulphide of iron; and the union takes place in the proportion by weight of fifty-six to thirty-two, simply because these numbers represent the relative weights of the two sorts of atoms. Now, Dalton may be wrong, and there may be no such things as atoms; but every science postulates fundamental principles, of which the only proof that can be offered is a certain harmony with observed facts; and the chemist assumes the reality of atoms and molecules because they enable him to explain what would otherwise be a chaos of unrelated facts. The combining proportions of substances, then, indicate their relative molecular weights; and, bearing this in mind, we must turn again for a moment to the physical side of the question, to inquire whether, and in what way, the physicist can determine the weight of a molecule.

Water, alcohol, and ether expand when heated, like other forms of matter, but they do so very unequally. Their vapors, on the other hand, are expanded by heat at exactly the same rate under like conditions. The theory supposes that the molecules which are close together in the liquids become widely separated when these are converted into vapors; and the action of the particles on each other becomes less and less as they are driven farther apart by heat, until at last it is inappreciated. When the molecules of the vapors in question are thus freed from other influences, it is found that heat acts in an exactly similar manner upon each of them; and this is found to be true of all gaseous bodies. The obvious explanation in the case before us is, that there are the same number of particles within a given space in the vapors of all three liquids. This is the law of Avogadro, which is formulated as follows: "Equal volumes of all substances, when in the form of gas, contain the same number of molecules"; and we shall see how simply this conception is applied for the purpose of determining the molecular weights of all bodies which are capable of being vaporized. It will be understood that we are still dealing, as in the case of chemical combination, with relative weights only. We have no means of ascertaining the absolute weight of a molecule of any substance; but we can state with perfect accuracy what relation these weights bear to one another. For this purpose, the molecule of hydrogen, which is the lightest body known to science, has been selected as the unit. Calling the weight of a litre of hydrogen one, we find by the balance that a litre of oxygen weighs sixteen; and as, by Avogadro's law, both litres contain the same number of molecules, the molecule of oxygen is sixteen times heavier than that of hydrogen. The mo-

lecular weight of any substance, therefore, which can be brought into the gaseous condition, is found by simply determining experimentally the specific gravity of its vapor relatively to hydrogen.

In this way the physicist ascertains the molecular weights of all easily vaporizable bodies, and these are found to be in uniform and exact agreement with those which the chemist deduces from the law of combining proportions. The molecular hypothesis is thus brought to a crucial test; and two entirely independent lines of inquiry agree in giving it support of such a character as compels conviction. The law of gravitation and the undulatory theory of light do not command more cogent circumstantial evidence than this.

We have now briefly reviewed the fields from which the certain data of molecular science are gathered. We have weighed the molecules of gases, and measured their velocity with a high degree of precision. But there are other points, such as the relative size of the molecules of various substances, and the number of their collisions per second, about which something is known, though not accurately.

With regard to the absolute diameter of a molecule and their number in a given space, everything at present is only probable conjecture. Still, it may be interesting to state the views which are held on these questions by such investigators as Sir William Thomson and the late Professor Clerk-Maxwell; but we give these without attempting to indicate the character of the speculations on which their conclusions rest.

Summing up, then, both the known and unknown, we may say that the molecular weights and velocities of many substances are accurately known. It is also *conjectured* that collisions take place among the molecules of hydrogen at the rate of seventeen million-million-million per second; and in oxygen they are less than half that number. The diameter of the hydrogen molecule may be such that two million of them in a row would measure a millimetre. Lastly, it is conjectured that a million-million-million-million hydrogen molecules would weigh about four grammes; while nineteen million-million-million would be contained in a cubic centimetre. Figures like these convey no meaning to the mind, and they are introduced here only to show the character and present state of the research.

A few concluding words must indicate the tremendous energy residing in the forces by which the molecules of matter are bound together. The molecules of water, for example, can not be separated from each other without changing the liquid into a gas, or, in other words, converting the water into steam; and this can only be accomplished by heat. The force required is enormous; but, since the determination, by Joule, of the mechanical equivalent of heat, we are able not only to measure this force, but also to express it in terms of our mechanical standard. It has been found that, in order to pull apart the molecules of one pound of water, it is necessary to exert a mechan-

ical power which would raise eight tons to the height of one hundred feet. Such is the energy with which the molecules of bodies grasp each other; such is the strength of the solder which binds the universe together.—*Chambers's Journal.*

SKETCH OF JAMES CRAIG WATSON.

By ALEXANDER WINCHELL, LL. D.

JAMES CRAIG WATSON, Professor of Astronomy in the University of Wisconsin, and Director of the Washburne Observatory at Madison, Wisconsin, died on the morning of November 23, 1880, after an illness of one week, at the age of forty-two years and ten months. Professor Watson was one of the most gifted and distinguished of modern astronomers, and his life-work is identified with the name of the University of Michigan.

He was born of American parentage, during a sojourn of his parents in Middlesex (now Elgin) County, Ontario, January 28, 1838. The mathematical genius revealed by the boy at the early age of nine determined the father to secure him a liberal education, and the family accordingly removed to Ann Arbor in 1850. Here James displayed equal aptitude for mathematical and linguistic studies, and, being prepared for college, almost without the evidences of effort, he entered the University of Michigan in the autumn of 1853. He attained equal scholarly distinction as a student of ancient and modern languages and of mathematics. It is said that, before the close of his junior year, he had performed the phenomenal feat of reading from beginning to end the "Mécanique Céleste" of Laplace. During his senior year, he was the solitary pupil of Dr. Brünnow, and graduated in 1857. His mechanical tact was such that, in the absence of a mathematical bent, he would have become an eminent mechanician and inventor. While in college, some of his spare hours were spent in grinding lenses and the construction of a telescope. Other portions of his time he was compelled to devote to the earning of means to defray collegiate expenses.

During the two years succeeding his graduation, he was employed as assistant in the Observatory, and in the prosecution of studies for his second degree. In this work he displayed such remarkable aptitude as an observer, and such marvelous rapidity in his computations, that, on the retirement of Dr. Brünnow, in June, 1859, young Watson succeeded him in the chair of Astronomy. He was already known as a frequent contributor to the "American Journal of Science," Brünnow's "Astronomical Notices," Gould's "Astronomical Journal," and the "Astronomische Nachrichten," of Altona. Not less than twelve

communications, written before he was twenty-one, are recorded in the Royal Society's "Catalogue of Scientific Papers," which also enumerates twenty-one others between 1859 and 1874. His wonderful keenness as an observer was signalized, while yet an undergraduate, by the discovery of a comet on the 29th day of April, 1856, and, four months after graduation, by the discovery of a planet on the 20th of October, 1857, which, however, proved to have been observed by Luther a few days before, and has been named *Aglaia*. His observations of Donati's comet, in 1858, possess a standard value, and his computation of the orbit is recognized as authoritative. The interest awakened by this comet prompted to the preparation of "A Popular Treatise on Comets," published early in 1860.

In 1860 Dr. Brünnow resumed the directorship of the Observatory, and young Watson was assigned to the chair of Physics in the university, which he retained for three years, when, on the final retirement of Dr. Brünnow, Watson was made Professor of Astronomy and Director of the Observatory, a position which he held and honored for sixteen years. Scarcely had he been clothed with full control of the instruments, when he resumed his remarkable career of discovery. There seemed almost a magic in his powers. Unrecognized celestial objects seemed to crowd spontaneously upon his notice. On September 14, 1863, he made his first independent planetary discovery. This was *Eurynome*. On January 9, 1864, he discovered the comet since known as 1,863, VI, which Respighi, as it proved, had already noted. On the 9th of October, 1865, he discovered a planet which also proved to have been announced by Peters, and has since been named *Io*. He discovered *Minerva*, August 24, and *Aurora*, September 6, 1867. During 1868 he added no less than six minor planets to the solar system, furnishing the only instance in which the list of planetary discoverers presents the same name four times in immediate succession.

Meantime he was engaged upon a work which might well have engrossed all his powers, and must have quite exceeded the abilities of any but a gifted mathematical genius. It was no less than a complete digest of the results and methods of all the great writers on theoretical astronomy, and an independent development of the great principles of the science. "Having carefully read the works of the great masters," he says in his preface, "my plan was to prepare a complete work on the subject, commencing with the fundamental principles of dynamics, and systematically treating, from one point of view, all the problems presented." This broad plan, conceived by a young man of twenty-eight, and completed when twenty-nine, was executed with ability so commanding, that the work, on its appearance in 1869, was immediately accepted as an authoritative exposition of the higher principles and processes of dynamical astronomy, and was made a text-book at Leipsic, at Paris, and at Greenwich. The same year he was sent by the General Government on an expedition to observe the

solar eclipse at Mount Pleasant, Iowa, and, in 1870, to Carlantini, Sicily, for a similar purpose. In 1874 he was appointed to the charge of an expedition to Peking, China, to observe the transit of Venus. His observations were favored by the weather, and conducted with consummate skill. The results, though reduced and discussed, are not yet published. Even at the antipodes, fresh discoveries awaited him. He had already raised his list of planetary discoveries to seventeen, and now added *Juewa*, the eighteenth. In 1876 he was one of the Judges of Awards at the Centennial Exposition, and wrote the celebrated "Report on Horological Instruments." In 1878 also appeared his "Tables for the Calculation of Simple and Compound Interest," a work which, in spite of the subject, is marked by great originality, and demanded a vast amount of wearisome labor. The same year he was sent by the General Government in charge of an expedition to Wyoming, to observe the total solar eclipse. Professor Watson, having long entertained a belief in the existence of an intra-Mercurial planet, as well as of an extra-Neptunian one, gave special attention at this time to a search for the former, and was the first astronomer to note certainly (July 29, 1878) the existence and position of the planet Vulcan. He also satisfied himself of the existence of a second intra-Mercurial planet. This brought the number of his original planetary discoveries to twenty-six (including one lost July 29, 1873, and two anticipated). He was now animated by an intense desire to control instruments of suitable power and adjustment to confirm his last observations, and enable him to detect the outlying planet beyond Neptune. Coincidently came the invitation to assume the charge of the Washburne Observatory at Madison, Wisconsin, which was to be improved and newly equipped with instruments far more efficient than those at Ann Arbor. The temptation was great, but he naturally clung to his alma mater, whose authorities made such efforts as they thought authorized to content their astronomer. But the requisite means could only be obtained by a grant from the Legislature, a measure defeated by an inadequate appreciation of the honor shed upon the State by such a name as Watson's. Reluctantly, but sustained by a high and noble aspiration, he removed, in the summer of 1879, to Madison, and immediately devoted himself with intense energy to remodeling the observatory structure, and introducing some original provisions thought to be suited to the special researches on which he was bent. A cellar twenty feet deep was sunk at the bottom of the first slope of Observatory Hill. Into this, light was to be thrown through a long tube, from powerful reflectors on the top of the hill. This, with other accessory work, was actually in progress, when a severe cold brought on peritonitis, which over-confidence in his physical powers permitted to reach a fatal stage before medical aid was summoned. His remains, accompanied by an escort from the University of Wisconsin, were removed to Ann Arbor, where they lay in

state, in the university, during the 25th of November, and, on the following day, with due honors and imposing ceremonies conducted by his late colleagues, were reverently laid beneath the shade of Oakwood Cemetery.

Professor Watson possessed extraordinary intellectual endowments. His quickness of perception nothing escaped. His mathematical intuitions scorned the ordinary processes of calculation, and gave him a masterly command of mathematical logic and formulæ, which made so many portions of his work on "Theoretical Astronomy" strictly original, and all parts virtually his own. Yet he never mentions any claim to originality, but pursues his majestic intellectual march with the dignity almost of an inspiration. His memory served him equally well. It was both circumstantial and philosophical. Every new observation was immediately illuminated by all which he had previously observed or known, and he saw instantly the proper conclusions. His mechanical gifts gave him perfect command of instruments and their construction, and the Washburne Observatory would have been equipped with several of his inventions. His versatility extended to matters of business. He was for years the actuary of the Michigan Mutual Life Insurance Company, and performed service pronounced invaluable. He managed his private means with such success that he died possessed of a considerable fortune, which his will secures to the National Academy of Science. Physically, he was vigorous and healthy, and reached, in the last years of his life, a weight of two hundred and forty pounds. His religious nature held fast to the fundamental religious beliefs. He used to say it is impossible for a mathematician to be an atheist, and his works offer frequent recognition of the being of the supreme Creator and Governor of the universe.

The world was not slow to recognize his worth. He was elected a member of the National Academy of Science in 1867, and of the Royal Academy of Sciences in Italy in 1870. He received the degree of Doctor of Philosophy from the University of Leipsic in 1870, and the French Academy of Sciences conferred upon him the Lalande gold medal for the discovery of six new planets in one year. Yale College honored him with the degree of Doctor of Philosophy in 1871. In 1875 the Khedive made him Knight Commander of the Imperial Order of Medjidieh of Turkey and Egypt. He was elected member of the American Philosophical Society in 1877, and received, the same year, the degree of Doctor of Laws from Columbia College.—*American Journal of Science.*

CORRESPONDENCE.

SELF-GOVERNMENT IN COLLEGES.

Messrs. Editors.

YOUR editorial on "Self-Government in Education," in which you give an account of the interesting experiment that has proved so satisfactory at Amherst College, suggests to me that Amherst is by no means a leader in applying the principle of self-government among students. In saying this I imply no detraction from the credit due to Amherst; on the contrary, it is rather a subject of congratulation that this college has been so conspicuously successful in carrying out a policy the importance of which has been long recognized, but which could not always be carried into effect.

A little over fifty years ago, the University of Virginia was founded as a group of independent schools in which students were permitted perfect freedom in the election of courses of study; and in their relations with the faculty the system of espionage, so universal in other educational institutions, was entirely discarded. The chairman of the faculty was of course brought into contact with students who abused their freedom, but the student's responsibility as a man was always recognized, and no trammels were imposed upon him beyond the obligation to respect the rights of others. It was assumed that he knew thoroughly the object to be attained by his attendance at the university, and the obligations implied in association with polite society. If he should fail to exercise enough diligence to win success in the final examinations, he himself was the only loser, and the opportunity was afforded him to try the same course another year. But if his example was deemed bad, or any disturbance was traced to him by ordinary methods without espionage, private admonition was bestowed by the chairman, or he was advised to leave. This advice, thus quietly given, was adopted, and the publicity of expulsion usually avoided. From personal experience in this institution ten years ago and again five years ago, the writer does not hesitate to say that as a student he enjoyed all the liberty that is afforded him in New York City as a member of society.

In 1866 the University of South Carolina was organized upon the same general plan that had been long carried into effect in Virginia, and with similar results. Owing to political complications in that State, the University was disbanded in 1870, but during its existence the principle of self-government among students was carried out in full. A students' court was occasionally held, and on no occasion did conflict arise with the faculty.

In 1870 a system of local self-government for the students was adopted in the State University of Indiana. The experiment has been on the whole successful, and a description of many of the details has lately appeared in print. There were at times difficulties which seemed to necessitate total abandonment of the plan; but each year's experience has given strength, and no return to the old system is now considered advisable.

The late report of the President of Harvard affords much that is interesting in relation to methods of college instruction and discipline. The growth of individual freedom for the student has been as noticeable as the increase of breadth in the scope of the university. The same remark applies to Columbia College, as shown by the last annual report of President Barnard. Indeed, in all of our best institutions of learning the day of espionage is past, recitation-marks are to a large extent abandoned, and students are regarded as agents that are not only free, but also self-respecting, responsible, and possessed of enough common-sense to appreciate the objects to be attained by entering upon a course of college study.

But the appreciation of self-government is not wholly confined to those who take part in the work of our higher institutions. In the columns of the New York "Evening Post," last December, appeared a series of articles on "Self-Government in Schools," in which the writer, one of the most successful teachers of our city, gave an exceedingly instructive recital of experiments which he has been cautiously conducting for a number of years past, to test the advisability of substituting the freedom of the republic for the centralized power of an autocracy in the schoolroom. He has found that a large measure of self-government is quite admissible, even where pupils are far below the age at which admission to college is possible. The president of the school republic subjected himself to the same laws by which juvenile voters were bound, and in the end found he had nothing to regret.

Indeed, every intelligent teacher in an intelligent community to-day, whether his sphere of duty be in the lecture-room, the class-room, or the schoolroom, has been

obliged to adapt himself to the evolution of society. If he fails to respect that freedom of thought, of belief, of action, which our civilization makes necessary in all social relations, he finds it necessary to seek other fields where social evolution is not sufficiently advanced to make him an interloper. The same spirit in society which has caused the abolition of the birch rod in school, except in cases of peculiarly low personal organization, has caused the abolition of espionage in colleges and universities. In calling the attention of your readers to the methods by which success is attained in institutions like Amherst, where not only the right but the duty of self-government among students is insisted upon, you are aiding the work of educational reform, and all such efforts are entitled to the acknowledgment of those whose work is education. W. LE CONTE STEVENS.

40 WEST FORTIETH STREET, NEW YORK, *July* 23, 1881.

INFORMATION WANTED.

Messrs. Editors.

WILL you permit me through the columns of your journal to ask for a scrap of information that I have been unable to obtain from any books at my command, or from any other source. Infesting the islands of Lake Erie is an insect which from all accounts plagues human beings in much the same manner that the chigoe or chigre—commonly called jigger—of the South is said to. The islanders call this insect a "midget," also a "jigger," and say that it is most numerous in bushes or the undergrowth of the woods; that it is almost invisible to the naked eye; and that when it effects a lodging on the human body it bores through, and lies under, the skin, causing the very annoying and sometimes painful "bites" that are experienced by visitors to the islands. I have frequently suffered from these "bites," which are far more distressing than the most aggravated mosquito-bites, but have never been able to find anything of the little pest that gives them. I am told, however, that, if a "bite" is examined as soon as it begins to itch, the "midget," an infinitesimal yellow insect, may be seen in its center. The "midget" seems to be unlike the chigoe of the West Indies and South America, judging by cyclopedic accounts of this latter insect, only in the respect that it does not, as far as I have been able to discover, rear its progeny under the skin it bores into. Perhaps you, or some of your readers, will be kind enough to inform me what the "midget" is, its true name, etc. Respectfully,

DEAN V. R. MANLEY.

TOLEDO, OHIO, *July* 16, 1881.

EDITOR'S TABLE.

THE LESSONS OF THE BOSTON "LADIES' DEPOSIT."

THE "Atlantic Monthly" did well in publishing in its July issue two articles on the "Ladies' Deposit," a fraudulent banking concern in Boston, of which so much was said last year. One of these articles, by Mr. Henry A. Clapp, gives a history of the scheme, and is evidently written with care and with good knowledge of the facts. The other paper is by Miss Mary Abigail Dodge, who had some experience with the institution, and she presents the feminine side of the case. As the excitement of the affair is now passed away, and we have the main facts fairly before us, it seems proper to look a little into the lessons it teaches; and to do this it will be desirable to recall briefly its leading features. In this we follow the statements of Mr. Clapp.

By whomsoever planned, the scheme of the "Ladies' Deposit" was carried out by a woman named Howe, and she was undoubtedly its master-spirit. The revelations at the sequel show her to have been a vulgar female impostor, a clairvoyant, and fortune-telling adventuress, who had run a long career of petty crime in New England. She first married a half-breed negro, or Indian, named Solomon, who is now living in Rhode Island. They lived together some thirteen years, but the marriage was void on account of the law against the union of persons of different colors. She next married a man named Lane, or Chase, Mr. Solomon being a diligent promoter of the second union. Lane is said to have died at sea, when she married Florimund L. Howe, a house-painter and dancing-master, who is her present husband. The pair adventured

about the country for several years, getting a miserable living in precarious ways, and the woman's conduct was at times so "queer" that in 1867 she was sent to the State Lunatic Asylum in Taunton, where she remained two years. In 1875 she was caught in the perpetration of an elaborate set of frauds and sent to jail, but got out before the expiration of her time through a technical mistake in her indictment.

She is represented as illiterate and in many ways very ignorant, but "she has always been a keen observer, a quick learner, and a shrewd student of human nature. It would be more nearly correct to call her unmoral than immoral; for from her extreme youth she appeared to have a serious constitutional difficulty in discerning the difference between right and wrong, between her own property and her neighbors'. All her thieving has been marked by a grand air of unconsciousness, rather than by eager, covetous greed. Her disposition seems to be somewhat good-natured and generous, and to show a kind of native *bonhomie*, and at the height of her prosperity as a 'banker' she became very popular with a certain set which was especially rich in mesmerists, fortune-tellers, and female physicians of the irregular sort." She has "abundant cunning," "a great natural gift of utterance," "a singularly plausible manner," and to her other accomplishments it must be added that "she is one of the most exuberant, spontaneous, imaginative, and unnecessary liars that ever breathed."

This woman at length planted herself down in Boston as a "banker." When she began, or how she began, is involved in mystery. Her scheme seems to have been copied in its main features from that of a Bavarian swindler—an ex-actress named Adèle Spitzeder—"which was operated in Munich from 1869 to 1872, and by which the Bavarians were cheated out of millions of dollars. . . . Both opened banks of deposit, promised preposterous returns of interest, and successfully invited loans of money from the public. Neither had any pecuniary capital or offered any security, the sole and sufficient reliance of each being upon her own impudence and the combined cupidity and credulity of her customers. Each made friends by playing the Lady Bountiful upon occasion, had a mixed party of gulls and knaves committed to her cause, drew herself out of poverty and into luxurious comfort by means of her bank, ended her career in prison, and left assets enough behind her to pay her creditors a dividend of about five per cent." It is significant that the astounding Bavarian fraud had run its course and exploded, and was reported all over the world seven years before the successful repetition of the experiment was made in Boston.

The main trick of Mrs. Howe was, however, a shrewd improvement upon the Bavarian method. For while Fräulein Spitzeder took deposits from everybody who would make them—high and low, rich and poor, male and female—Mrs. Howe artfully restricted the benefits of her institution to women, and to those, moreover, of small means. No woman owning a house could make a deposit, and no deposits were received less than two hundred dollars, nor more than one thousand dollars. Interest at the rate of eight per cent. per month was paid every three months—that is, twenty-four per cent. quarterly—and the payment was in advance. To the question how it was possible to pay such large interest, the reply was, "We never disclose the methods by which we do business"; "we do not solicit"; "you need not deposit unless you wish"; "we never give references." But, notwithstanding this, it was stated that the "Ladies' Deposit" is a charitable institution for the benefit of single ladies, old and young, of small means, and it was obscurely intimated that the money was intrusted to the

Boston agency for this charitable use by a rich "Quaker Aid Society" of Virginia. Mrs. Howe refused to tell how the funds thus derived were invested, because, as she craftily said, "she was afraid of the displeasure of her superior officers." Yet, thoroughly baseless as was the project which could give no open account of itself, and utterly absurd as were its promises, it nevertheless had a rushing success. Each new depositor had to be introduced by a previous depositor. There was a great show of strictness in inquiring into their fitness. The first depositors, when they had got their enormous interest, reported it to their friends, and the craze spread rapidly among the Boston women to avail themselves of the speculation. That they were the recipients of a charity made no difference. The bank would have nothing to do with men, and constantly encouraged the idea that women were abundantly capable of transacting their own business without masculine advice. And so money poured in by the thousands. The big interest was paid out of the influx, and if a depositor wanted her money back she could have it any day but Sunday, and with it she got the curt notice that she need not apply again. The result was that the "miserable old rogue," with her "swindling savings-bank," in the course of a few months drew from the pockets of ten or twelve hundred New England women no less than half a million dollars. The "Boston Advertiser" at length attacked the concern vigorously, and it collapsed in three weeks. A few of the earlier depositors received their large interest, and got out also with their principal; but when the scheme was pushed into insolvency there remained only five per cent. of their investments for some eight hundred depositors.

As was natural, the women who had walked into this trap and lost their money were roundly denounced for their credulity and business incapacity. Miss Dodge resents this charge in her usual spirited way, launches profuse invectives upon the men who broke up the fraud, and, while not excusing Mrs. Howe, defends her sex from the assaults of masculine "insolence, ignorance, and stupidity." She proposes to show that "the history of the Ladies' Deposit does not demonstrate the credulity of women, the immorality of women, or the educational or political incapacity of women." If not successful in proving these positions, she, at any rate, shuts the mouth of her masculine critics by showing that men too are abundantly imposed upon and cheated, and are therefore credulous and stupid as well as the women.

The subject is here widened, and our chief interest in the affair relates to this aspect of it. What are the conditions that made this transaction possible? What are the causes that led to it and which lead to other kindred results? The particular event has passed away, and in itself is of but little moment; but what sort of a tree is that which bears such fruit? The state of mind that produced it still continues, and we may expect the same things to be done again and again, with only a change of names, forms, and tactics. That which has just now had a conspicuous feminine expression is by no means wholly an affair of sex, but is a common phenomenon. The Ladies' Deposit was in fact but a drop in the bucket compared with the omnipresent impostures and cheats of all grades and qualities which are transacted everywhere. What is the condition of mind which leads to them?

We state nothing new in saying that such impostures as Howe's bank prove a widespread deficiency in mental cultivation. It has been urged that there is a gross want of instruction in our schools in the elementary principles of economics, a knowledge of which would serve as a protection in emergencies of

this kind. Undoubtedly more of political economy in our common-school education would be useful, but it must be remembered that our swindles are by no means limited to the financial sort, while the public mind is probably more alert in this direction than in any other. To rectify the evil by the application of special knowledge would require scores of new subjects to be introduced into our public-school curriculum. Besides, had political economy been taught in the New England schools as other things are there taught, we are not sure that it would have made much difference with the chances of Mrs. Howe's banking adventure. The difficulty was not so much a lack of knowledge on this particular subject as a lack of that mental preparation which would qualify for meeting the whole class of impositions of which the Ladies' Deposit was but a single example.

The Boston women were undoubtedly cheated through their credulity, and this state of mind was palpably exemplified by a thousand of them. But the same state of mind is exhibited by many other thousands of both men and women all over the country; and it is this which has to be met by education before any efficient protection can be gained against its mischievous results. Credulity is easy belief, and the correction of it is, of course, hardness of belief. The credulous person is careless of evidence, and is, therefore, readily duped; the only remedy for this is doubt, distrust, an appreciation of the importance of evidence, and a trained capacity to judge of it. It is necessary that this state of suspicion and questioning become a habit of the mind, and the sifting of evidence in practical affairs a distinct branch of mental cultivation. To escape the evil effects of credulity it is needful that disbelief as an attitude of mind be encouraged as a virtue. The resistance to evidence must be active and vigorous until it is proved to be not spurious and illusive, but sound and valid. Our current culture is here profoundly at fault. Literary education, as such, does not favor this habit of mind; scientific education properly pursued leads to it necessarily. Literature flourished in its highest forms in the ages of credulity, while modern science only arose with the growth of the spirit of doubt. Training in the methods of scientific study seems, therefore, to us, the only adequate remedy for that laxity of thinking and dull credulity of the popular mind in which widespread deceptions and impostures have their origin.

But science also greatly helps us here in the things it teaches. It familiarizes the mind with the conception of an order in human life, the invincible operation of cause and effect in social affairs, and the laws of proportion between actions and consequences to which all persons are subject. That there are natural laws in society which work out their inevitable results is a lesson that requires to be learned as well by the individual as by the state; and scientific education alone can familiarize the minds of the young with this vital truth.

Here our literary education fails. It does not reach, and expound, and enforce this class of ideas. It is so thoroughly verbal and critical in form and spirit as actually to arrest the mind on its way to the study of things. In this way absorption in literature becomes a barrier to science, which, by its nature, must deal directly with facts and principles. Science merely addressed to the apprehension, and lodged in the memory like literary acquisitions, is not true science; and little would be gained by introducing social science into our schools, to be pursued there in the manner of other studies. Literary culture, as it predominates in our educational institutions, neither prepares the mind to deal intelligently with questions of evidence nor does it imbue it with right conceptions of social order

and the laws of human relation, and it, therefore, affords but little protection against those vagaries and extravagances of belief which have their root in credulity.

Miss Dodge's apology for the women, in the "Atlantic," is a good illustration of this. Keen, brilliant, thoroughly cultivated as she is, she does not seem for a moment to recognize that the first duty of every woman introduced to Howe's bank was to demand and insist upon the clear evidence of its validity. She does not seem to consider that intelligence or judgment of facts had any function in the affair. Promises certainly extravagant were made, and stories certainly improbable were told, and they were all swallowed without a serious question, but Miss Dodge can see no credulity in it! The notion that the concern was a grand charity appeared so possible, so probable, and so noble, that the poor women were justified in investing in it without any of those precautions that are dictated by universal experience in these matters. Indeed, Miss Dodge seems to think that Howe's bank is a kind of ideal type of beneficence on which this miserable world might well be remodeled. In the good time coming we are entitled to expect boundless largess, and a thundering rate of interest for everybody. She says: "If there had been a great charity at the basis, I do not see how any wiser mode of distribution could have been framed. In view of the inexpressible relief which was afforded in the dozen or so cases of which I learned in the course of the discussion, I feel a thrill of regret whenever I remember that there was nothing in it."

As a matter of probability, that is of evidence as a basis of action, Miss Dodge thinks that eight per cent. a month is not half so incredible or absurd as the working of the present order of nature. With God's government of the world at a paltry six or seven per cent. annually she seems disgusted, declaring, "In regard to general probability I candidly avow that no originality and no magnitude of charity is so incredible as that the Omnipotent Creator of the world should let things go on as they are."

Miss Dodge reasons that the women were excusable for patronizing Mrs. Howe's bank with its magnificent promises because people do actually get benefactions often princely in all sorts of irregular and improbable ways. Dr. Cullis's Home for Consumptives in the heart of Boston, professedly supported by prayer alone, and the Woman's Faith Home for Incurables, in Brooklyn, supported also as is said by faith and prayer, are thought worth referring to, and she adds, "If Christ could fish up money out of the sea wherewithal to pay his taxes, and if he said, 'He that believeth on me, the works that I do shall he do also, and greater works than these shall he do,' why should it seem a thing incredible that he should pluck from the pockets of the rich a hundred-fold or ninety-six-fold the slender means of the deserving poor?"

These are side-considerations for her religious critics, but Miss Dodge thinks that politics teaches the same lesson. She says, "No one can live long and intimately in political circles without being prepared for any development whatever of generosity and magnanimity." Most true!—and alike in Howe's bank and in politics we are not to inquire too curiously into the sources of the generosity. It was the pride of Tweed that he took splendid care of his friends, and the magnanimities of political circles are too generally in proportion as politicians are thieves—they are proverbially generous with the public money! But, even where politicians are not thieves, their circles are full of bounties in the shape of offices and patronage that come as chance advantages to the undeserving, like lottery-prizes

and runs of luck at the gaming-table. In this aspect of its influence the school of politics is thoroughly demoralizing. Nothing is better calculated to subvert all manliness and independence of character than the habit, now become so general in this country, of making politics a business, and depending upon the bounties of government as if it were a kind of earthly providence. It is in the wise order of things that people shall depend upon their own efforts, and prosper through the virtues of industry, frugality, and self-denial. There will be misfortune, and there is a function for discriminating charity; but no teaching is more unwholesome than that which encourages people to count upon the generosity of the rich, government, favor, or something to turn up. Miss Dodge's view of life does not correspond to the realities of life, and is, therefore, a bad preparation for the experiences of life. Quite other views must prevail before we shall see the last of such pitiable experiments as that of the Ladies' Deposit.

STATE EDUCATION.

We last year republished an article by Sir Auberon Herbert, questioning on various grounds the policy of state education. We received several answers to it of various merit, and still more various logic, but they all agreed upon one thing—that state education is indispensable to the preservation of the republic.

We print this month an answer to Mr. Herbert, which is as able as any that have reached us, and has a kind of tacit authority as coming from a public official engaged in the special work of organizing and consolidating a state school system. The writer, Mr. Charles S. Bryant, is Secretary of the High School Board of the State of Minnesota, which is charged with the duty of prescribing and adjusting the courses of study to be pursued in a concatenated or unified system of state schools, from the primary to the university. Mr. Bryant is an advocate of state education in its most comprehensive form, and he also maintains that the right of the state to take charge of this great work is necessary to its self-preservation.

We are abundantly told that this is, to all intents and purposes, a settled question; that government education is nothing less than manifest destiny, and the most foregone of all American conclusions. And we have just here already one of the fruits of the experiment—the borrowing of the political method of buncombe and bullying to force the acceptance of a desired measure, and stave off criticism as a matter of no account. But it is necessary that the subject should be freely discussed, and the more necessary that the principles involved should be thoroughly canvassed, and the objections to the policy fully pointed out, because of the great popularity of the policy and the disposition to push it to its utmost extremes. The question is no longer of the expediency of giving state aid for the primary instruction of the children of the indigent classes who claim to need assistance; but it is whether the government shall undertake this work in all its grades, and take the property of the people to make this whole service a gratuity.

The advocates of government education are given to representing it as an issue between state education and no education at all; and the opponents of the measure are often stigmatized as being in favor of illiteracy and ignorance. But this is a profound mistake. State education is intelligently and earnestly opposed in the highest interest of education. The intervention of the state is resisted because it can not do in the best manner what it undertakes to do—because education by authority and political machinery must fall to a lower standard than that which

has been attained by former methods. Mr. Bryant argues for the state compulsory system as against the voluntary system, but the great advancements of civilization have been incontestably made by private enterprise, and spontaneous coöperation among the members of the community, and with these things the state has only meddled to hinder. The state originates nothing; its highest office is simply to secure the conditions under which the voluntary combinations of individuals for desirable objects shall have the fullest and freest play. Nor is the progress of education any exception to this law. The work of originating and extending knowledge, and of diffusing it by the formation of schools, the organization of societies, the institution of academies, and the establishment of colleges, has always been mainly done by the individual forces of society working under voluntary coöperation and independent of government. Besides, all the tendencies of modern progress are to give larger scope to private enterprise, and to relinquish to the people prerogatives that formerly belonged to government. It is now proposed to contradict this law of advancement by surrendering to the state the whole duty of directing the mental development of its citizens.

Mr. Bryant maintains that the right of state control in the matter of education is a necessary consequence of state sovereignty, and he argues that, in the course of political development, the family is superseded, the state assuming the parental functions. He says: "The child passes, in any organized society, through all the grades in the related social state. In the same order, also, government passes on, until it rests in the control of sovereignty, *the state*. And the right of the state to the custody and control of the citizen is as complete as the right of the parent to the control of the infant child. These are only the natural laws belonging to the several relations in the growth of society in all artificial conditions, under all governments. State control, therefore, comes into rightful exercise of authority over the education of every human being entitled to the privileges and protection of government. The particular age at which state authority may rightfully interfere in this relation is a matter of state policy and sovereign discretion."

Here, again, the law of progress is misread. Nothing is more certain than that it has resulted in cutting down state sovereignty to make room for individual rights. Man's development has ever been an acquirement of rights against the state, and, in all political advancement, the state has consequently become less and less, and the citizen more and more. The progress of civil liberty has been from the beginning a wresting of power from despotic state sovereignty. Men fought early and desperately for the right of life—that is, that they should not have their heads cut off at the caprice of a sovereign will. They wrung from the state the right of the individual ownership of property. They reduced the functions of the state when it repressed free speech for its own sovereign purposes. They stripped the state of its power of determining what religion it thinks best for the community, and thus secured the rights of conscience. In all these things, and in many more, government has been restrained and hampered in its tyrannical meddlings, and the people have correspondingly gained in liberty. The state has always assumed that it knew more about what was good for the people than they knew themselves. What we call liberty is nothing more than the right of the people to be their own judges, and to manage their own concerns in the way that seems best for the promotion of their own interests. But Mr. Bryant interprets state sovereignty in a way that dissolves all individual rights. If the state may interfere at its

"sovereign discretion" to extirpate the family in the matter of education, if it may take away a child as soon as it is ready for the Kindergarten, and dictate the whole course of its cultivation, stamping its character with a view to state objects, what else may it not do, and what becomes of the vaunted freedom of the citizen? The doctrine belongs to despotism, and was first and fitly practiced in Prussia as a means of shaping subjects to the uses of kingly power.

And now what *is* the state that claims such prerogatives in virtue of its sovereignty, and proposes to take the education of the whole community into its own hands? Divested of the glamour that surrounds this venerable abstraction, that which remains of actual reality is simply a lot of men got together to carry on the practical work of government. The state lives in the life of its representatives. It exists only as embodied in its officials. Certain men are chosen to make, repeal, and execute the laws, and these are the state. The state can do whatever they can do; the state is whatever they are. But we are not yet down to the naked reality. The community is divided into two great political parties, and the one that beats by numbers at election takes the government. Successful office-seekers, therefore, constitute the state. Those who succeed in partisan politics are those who cultivate the art of partisan politics. What these arts are, and what is the general quality of those who win by them, we need not say. But it is notorious that men of intelligence, integrity, and character are not successful partisans. It is the intriguers, the wire-pullers, and the crafty, unscrupulous managers in caucus and convention that win, and these men form the state. We do not exaggerate: witness the last Legislature of our own State. Humiliating as it may be to our patriotic pride, every candid person knows it to be a fact that an election under our representative system, with its inevitable caucus and convention machinery, is simply a winnowing out of superior men and the choice of the worst to take the offices of state.

We need not dilate upon the consequences; they are known and read of all men, and the lesson they teach has been freely drawn. If any worthy or meritorious thing is to be done, the significant exclamation is, "In Heaven's name keep it out of politics!" Such, indeed, is the growing disgust with political doings that it is now quixotically proposed to take even office-holding out of politics. And, yet, there are those who would intrust our politicians —ignorant, self-seeking, unscrupulous, and corrupt as the great mass of them are—with the whole work of education in society. Who is so senseless as to look for educational progress in such a condition of things? The system will be turned to the purposes of demagogism as surely as effect follows cause. The management of institutions of learning will become an art of getting state appropriations. The educational system will become rigid in proportion to the extent and complexity of its gradations, and will resist all improvement. Teachers, inspectors, superintendents, become office-holders and stipendiaries under the Government, and all animated with the common purpose of getting their salaries increased. Education, as a function of the states, must become a branch of mercenary politics. And this system, by its vicious growth, and its prestige of authority, and the boundless means at its command, must rival and overcome and extinguish all that private and voluntary interest in the work of education to which we are indebted for the past achievements in this important field of effort. Good may come from state education, but it will not be unmixed good, and it is at least an open question whether the evils of the system, where it is fully

carried out, will not be far greater in the long-run than its benefits.

The many American friends of Mr. Herbert Spencer will be pleased to learn that he contemplates visiting this country next year. He has long wished to do so, but has been deterred from seriously thinking about it by the state of his health, which forbade the venture of an Atlantic voyage. But he is now so much better that this difficulty is removed, and he hopes to come over some time next summer.

LITERARY NOTICES.

THE BACTERIA. By Dr. ANTOINE MAGNIN, Translated by GEORGE M. STERNBERG, M. D., Surgeon United States Army. Boston: Little & Brown. Pp. 227. Price, $2.50.

THE readers of "The Popular Science Monthly" have been from time to time informed concerning the progress of inquiry in relation to those lowest, minute, and curious organisms now known under the general name of "Bacteria." The first observer who perceived them was the father of microscopy, the Dutchman Leeuwenhoek, as early as 1675. He was examining with his magnifying-glasses a drop of putrid water, when he remarked with profound astonishment that it contained a multitude of little globules which moved with agility. In 1773 they were studied by O. F. Müller, and classified as a group of the *Infusoria*. They soon began to occupy a good deal of the attention of microscopists, and there was much conflict of opinion about their nature, as was inevitable from the novelty of the research and the imperfection of instruments. At one time they were considered as animals, and at another they were taken for plants; were now ranked as *Algæ*, and again as fungi. But it is only in the present generation that our knowledge of them has become so perfect as to lead to a large amount of agreement among observers respecting their nature, varieties, and classification. It is now recognized that they are the lowest organisms, standing upon the limit of the two kingdoms, animal and vegetable, and are thus defined by the botanists who have most recently studied them: "Cells deprived of chlorophyl, of globular, oblong, or cylindrical form, sometimes sinuous and twisted, reproducing themselves exclusively by transverse division, living isolated or in cellular families, and having affinities which approach them to the *Algæ*, and especially to the *Oscillatoriæ*." There has been, as our readers are aware, a long and intense struggle over the question of their spontaneous generation, but the great preponderance of opinion is now against that mode of origin. They vary much in form and dimensions, but are regarded as the smallest of all microscopical beings. Some of them are motionless, but they are generally remarkable for the movements they exhibit. These are thus described by the eminent observer Cohn:

> In certain conditions they are excessively mobile; and, when they swarm in a drop of water, they present an attractive spectacle, similar to that of a swarm of gnats, or an ant-hill. The bacteria advance, swimming, then retreat without turning about, or even describe circular lines. At one time they advance with the rapidity of an arrow, at another they turn upon themselves like a top; sometimes they remain motionless for a long time, and then dart off like a flash. The long rod bacteria twist their bodies in swimming, sometimes slowly, sometimes with address and agility, as if they tried to force for themselves a passage through obstacles. It is thus that the fish seeks its way through aquatic plants. They remain sometimes quiet, as if to repose an instant: suddenly the little rod commences to oscillate, and then to swim briskly backward, to again throw itself forward some instants after. All of these movements are accompanied by a second movement analogous to that of a screw which moves in a nut. When the vibrios, in the shape of a gimlet, turn rapidly round their axis, they produce a singular illusion: one would believe that they twisted like an eel, although they are extremely rigid.

An order of beings so amazingly minute that the various kinds of them are just barely revealed by the utmost powers of the microscope, might seem of little importance, at least, practically, in this world's concerns. But this is not so. The bacteria are at the foundations of life, and it is now admitted that they have a grand office in relation to the general preservation and continuance of life. Exactly in what way is perhaps not yet determined; but they are in some way

essential to the carrying on of vital organic changes. Dr. Magnin says, in his introduction: "It is known that organic matter once produced, and become solid, so to speak, can not again enter into the general current until it has undergone new transformations—metamorphosis *produced* according to some, *favored*, according to others, but without contradiction *accompanied* by the development of bacteria. And without wishing to attribute to these organisms a finality which is repugnant to our monistic conception of the universe, it may be said that it is, thanks to them, that the continuance of life is possible on the surface of the globe."

But the interest of these organisms is still more marked in practical directions. Their germs are in the air; they are distributed in the waters; and they swarm and propagate with astonishing profusion in organic liquids and infusions. They are involved in the processes of fermentation and putrefaction, and they have a *rôle* in the operation of violent diseases, such as variola, scarlatina, measles, diphtheria, typhoid fever, etc.; while their agency in connection with wounds gives them the highest interest to the surgeon.

It was therefore a capital service to science that was performed by Dr. Magnin in the preparation of this careful and complete book on the general subject at the present time. His volume is an ample report on the present state of what may be called bacterial knowledge. It is accompanied by faithfully executed plates and photographs, and contains, furthermore, an elaborate and exhaustive bibliography of the subject.

As a further illustration of the practical interest of the investigation here digested, it may be stated that Dr. Sternberg was led to translate it in consequence of its value in carrying on the work of the National Board of Health, the phenomena being vitally connected with various problems of public hygiene. The work has claims upon the scientific naturalist, the physician, and the non-professional man of general culture.

LIFE OF VOLTAIRE. By JAMES PARTON. In two volumes. Boston: Houghton, Mifflin & Co. Pp. 1,292. Price, $6.00.

MR. PARTON has been for many years a critical and deeply interested student of Voltaire and his times, and he has now given us the fruit of his studies in these two most entertaining and instructive volumes. Of Mr. Parton's large experience as a biographer, and his proficiency in the art, it is unnecessary to speak. He has had a life-long preparation in this branch of literature, and now, in the maturity of his powers, he has produced a comprehensive work, that will enhance his reputation, and undoubtedly prove a valuable and prominent acquisition to our biographical literature. There was greatly needed a good life of Voltaire, both on account of the great historic interest of his personality, his profound influence upon his age, and the mass of prejudice and misrepresentation that has been piled upon his memory during the last hundred years. The task of clearing away the errors, and arriving at such truth as the circumstances allow, has been performed conscientiously by Mr. Parton with unsparing labor, and, so far as we can judge, with eminent success. He has made exactly such a book as we wanted ourselves, and we believe it will adequately meet an extensive need among American readers.

We note that some exceptions have been taken to the work by English critics, who write about it in a somewhat disparaging tone; and, perhaps, some reference to their treatment of it may be helpful in judging of its real merits. But it is necessary to bear in mind the nature and difficulties of the task which Mr. Parton had before him, and these can not be better stated than in his own prefatory words. He says:

> I attempt in these volumes to exhibit to the American people the most extraordinary of Frenchmen, and one of the most extraordinary of human beings.
>
> When first I ventured, many years ago, to think of this task, I soon ceased to wonder why a subject so alluring had not been undertaken before by any one employing the whole of the existing material. Voltaire was then buried under a mountain of heterogeneous record. The attempts of essayists, even those of the first rank, to characterize him truly, were in some degree frustrated by an abundance of unsorted information that defied all ordinary research. Since that time the Voltairean material has continued to accumulate, and never so rapidly as during the last three years.
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> At this moment, if I lift my eyes from the desk on which I write, I see before me volumes containing fifty thousand printed pages of his composition, including more than two hundred and sixty separate publications. The published

correspondence of Voltaire now comprises more than ten thousand letters. The works relating to him and his doings form a catalogue of four hundred and twenty-eight entries, which will probably be increased before these volumes see the light. Scarcely a month passes without some addition to the wonderful mass. At one time it is a series of letters found in a grocer's shop, or rendered accessible by the death of an heir of one of his princely correspondents; now, an enterprising editor gives his readers an unpublished poem; recently, Mr. Gallatin deposited in the library of the New York Historical Society sixty-six pieces of paper and card containing words written or dictated by him; and in September, 1880, came from Paris the announcement of "Le Sottisier de Voltaire," from one of the eighteen volumes of manuscript in his library at Petersburg. No sooner is an edition of his works published, than it is made incomplete by a new discovery. Since the issue of the ninety-seven-volume edition in 1834, enough matter has accumulated to fill six or seven volumes more.

Still more strange, the mass of his writings, and I may even say every page of them, has to this hour a certain vitality and interest. If it has not intrinsic excellence, it possesses the interest of an obsolete kind of agreeable folly; if it is not truth, it is a record of error that instructs or amuses. He was mistaken in supposing that no man could go to posterity laden with so much baggage. In some cases it is the baggage that floats him, and many readers of today find his prefaces, notes, and introductions more entertaining than the work hidden in the midst of them. Nearly every 'page of this printed matter contains at least an atom of biography, and I can fairly claim to have had my eye upon it, indexed it, and given it consideration.

The reader is probably aware that every circumstance in the history of this man, from the date of his birth to the resting-place of his bones, is matter of controversy. If I had paused to state the various versions of each event and the interpretations put upon each action, this work would have been ten volumes instead of two. It would have been, like many other biographies, not a history of the man, but a history of the struggles of the author in getting at the man. Generally, therefore, I have given only the obvious or most probable truth, and have often refrained from even mentioning anecdotes and statements that I knew to be groundless. Why prolong the life of a falsehood merely for the sake of refuting it?

The Voltaire of these volumes is the nearest to the true one that I have been able to gather and construct. I think the man is to be found in these pages delineated by himself. But he was such an enormous personage, that another writer, equally intent upon truth, could find in the mass of his remains quite another Voltaire.

Now, it is obvious enough from these statements that the work of sifting materials and discussing minutiæ in regard to Voltaire, his multitude of works, and the interminable comment thereon, might have no end. Its perfection, according to the ideals of a pedantic scholarship, is impossible. Numberless details must remain for ever unsettled, and there would remain room for charges of error, no matter how far investigation was pushed. Mr. Parton is the last man who will claim that his treatment of the subject is infallible, but he may justly claim that he has gone as far as fair criticism can demand, toward making his book accurate and trustworthy. Mr. George Saintsbury, who has the reputation of being "one of the highest English authorities on French literature," reviewing Mr. Parton's work in "The Academy," recognizes that Mr. Parton is no "mere book-maker," but a "perfectly honest writer, and appears to have digested his enormous materials with a great deal of diligent effort"; but he thinks he has failed in producing "a work of art and an independent contribution to literature." And what is the evidence of this? Why, that "an innumerable multitude of small errors disfigures his pages." Mr. Saintsbury read the first 250 pages of Mr. Parton's book in careful search of defects, and says that he finds on the margins no less than fifty-four black marks, indicating what he deems imperfections. Some are awkwardnesses of expression, some excusable slips, some inept observations, some critical mistakes, and some actual errors. The examples he gives show the triviality of the blemishes he has marked, and they are mainly of a sort which could never be perfectly eliminated from a performance of this kind. Mr. Saintsbury objects that Parton's biography is not a "work of art," but works of art appeal to the taste, and tastes differ. Mr. Saintsbury comes to his work of criticism as "one of the highest English authorities on French literature." He is an adept in Voltairean studies, and in the first half of a large volume he finds fifty-four petty flaws, some of which are differences of opinion, and some, no doubt, real faults. We want no better evidence of the general ability and fidelity of the work than that a master of the subject can find no more to say against it than is stated in this criticism of "The Academy."

MARINE ALGÆ OF NEW ENGLAND AND ADJACENT COAST. By Professor W. S. FARLOW. Reprinted from the Report of the United States Fish Commission for 1879. By GEORGE A. BATES. Salem, Massachusetts. Price, $1.50.

SINCE the publication, by the Smithsonian Institution, nearly twenty-five years ago, of Harvey's "Nereis Boreali-Americana," there has been no work on United States algæ, except formal lists, to which the student could refer. Dr. Farlow, who is one of the most eminent algologists in the country, has given us in this work a compact hand-book which will be of great service to the collector and student. In the introduction much interesting information is given regarding the distribution of species along the coast. Cape Cod forms a barrier to many species. Dr. Farlow says the difference between the flora of Massachusetts Bay and Buzzard's Bay, which are only a few miles apart, is greater than the difference between those of Massachusetts Bay and the Bay of Fundy. This difference is found to correspond precisely with what is known of the fauna. He speaks of the occurrence of southern species of sea-weeds in a small sheet of water near Gloucester, to which the sea has access during a small portion of each tide, and, in referring to the presence of certain northern species south, says, "It seems to be the rule that wherever the water is cold enough we meet Arctic species, and wherever it is warm enough we have Long Island species, regardless of the remoteness of localities where the species naturally abound, and, as far as we know, of the absence of currents to transport the spores." The book closes with an excellent bibliography, and fifteen plates containing fifty-seven figures.

HAND-BOOK OF CHEMICAL PHYSIOLOGY AND PATHOLOGY, WITH LECTURES UPON NORMAL AND ABNORMAL URINE. By VICTOR C. VAUGHAN, M. D., Ph. D., Lecturer on Medical Chemistry in the University of Michigan. Ann Arbor Printing and Publishing Co. Pp. 347.

THE second edition of this work was called for in 1879, the first having been speedily exhausted. A third edition, revised and enlarged, appeared last year. The nature of the work is expressed in its title. It makes no claim to completeness, but is offered as a guide to the student who desires to pursue this branch of study. The latest authorities have been followed, and free use has been made of standard works and journals treating upon the various subjects discussed. In the present edition there is appended a second part, consisting of finely executed plates for illustration of the text. The book may be commended as giving within reasonable limits an excellent account of chemical physiology and pathology.

"ENGLISH PHILOSOPHERS, DAVID HARTLEY and JAMES MILL." By Mr. G. S. BOWER, M. A. New York: G. P. Putnam's Sons. Pp. 250. Price, $1.25.

THE reason why these authors are reviewed in company is probably because James Mill's system forms a sort of sequence to Hartley's, although this sequence is manifestly due more to the incidents of general intellectual growth in England than to any relation of discipleship between the authors.

The doctrine of association is shown to have first received a definite form at the hands of Hartley, although its inception as a principle is traced as far back as Aristotle. James Mill elaborated this doctrine, having at his command richer stores of science, but deprived it of some of those wider applications which later writers have adduced, and which were foreshadowed by the superior imagination of Hartley. To quote the author: "Let us first find a statement of the doctrine of association, in its very simplest terms. So far Hartley and James Mill are perfectly at one. We will take the definition given by the latter. 'Our ideas,' he says, 'spring up, or exist, in the order in which the sensations existed of which they are copies. This is the general law of the association of ideas, by which term, let it be remembered, nothing is here meant to be expressed but the order of occurrence.'"

On the whole, Hartley's conception of the doctrine was more physical than Mill's. He called it a theory of vibrations. The counterpart and development of this theory of vibrations, as explained by Hartley, is to be found, the author tells us, in the "neural tremors" described by G. H. Lewes and Dr. Maudsley.

A very simple and, perhaps, more ad-

vanced view of it might be expressed as follows: If all the physical forces are but affections of matter, quivering particles of the medium affected, it is easy to see that the senses, which we find to be special adjustments of ourselves to these different forces, are merely channels of different kinds of motion leading to the brain. In a word, therefore, the sensation of light is a definite motion of a definite part of the brain. If it were possible to study the lines or areas of motion which a sensation of a given intensity sets up in the brain, or the structural changes which accompany the repetition and combining of different sensations, there would be some hope that the physical or subjective aspect of the law of association could be explained. The difference between the apprehensions of this law by Hartley and Mill is that Hartley, being a physiologist, and moved by the excitement of discovery, endeavored to portray the subjective aspect of this law, while Mill devoted himself to its manifestations in the relations and history of life.

The author has made a great many selections from these two writers, which has the effect of bringing their systems into view side by side. He precedes these selections with a biographical sketch of Hartley and Mill, and accompanies them with comparisons and criticisms of his own, which constitute the greater part of the book. The value of such a book depends, of course, upon the point of view from which the criticisms are made, and the skill of the selections. With regard to the latter, but little improvement could be suggested, and, although some opportunities have been neglected of bringing important points into bold relief, the criticisms are remarkably just and free from error.

TEXT-BOOK OF EXPERIMENTAL ORGANIC CHEMISTRY FOR STUDENTS. By H. CHAPMAN JONES. New York: D. Van Nostrand. Pp. 145.

THE author of this book has added another to the already considerable list of useful little manuals on practical chemistry. He confines himself to organic chemistry and has endeavored to make the study of that branch of science more interesting to the quite elementary student than has been done by previous authors. The work is not a text-book, but merely a laboratory companion for the student, and is, moreover, especially arranged for those who have but a limited time at their command. It is not illustrated, though a good number of simple experiments are described.

THE BOTANICAL COLLECTOR'S HAND-BOOK. By Professor W. WHITMAN BAILEY. Naturalists' Handy Series, No. 3. Salem, Massachusetts: George A. Bates.

THIS is precisely what its name implies. The contents are arranged under the general headings of Herborizing, Field-Work, Collecting and preserving Fungi, Closet-Work, The Herbarium, Bibliography, Herbaria, and Public Herbaria.

Under each of these headings much valuable information for the collector is given.

PUBLICATIONS RECEIVED.

The Epidermal Organs of Plants: Their Morphology and Physiology. By Charles F. Cox, F. R. M. S. Pp. 15.

A Report on the Teaching of Chemistry and Physics in the United States. By Frank Wigglesworth Clarke, S. B., United States Bureau of Education. Pp. 219.

"The Tonic Sol-Fa Advocate." Edited by Theodore F. Seward. Vol. I, No. 1. New York: Biglow & Main. Monthly. Pp. 16. 50 cts. a year.

Annual Report of the Board of Directors of the Chicago Astronomical Society, together with the Report of the Director of Dearborn Observatory. 1881. Pp. 16.

Descriptions of some New Tortricidæ (Leaf-rollers). By C. V. Riley, M. A., Ph. D. Washington. Pp. 9.

Some Double and Triple Oxalates containing Chromium. By F. W. Clarke. The Titration of Tartaric, Malic, and Citric Acids, with Potassium Permanganate. Preliminary Note. By F. W. Clarke. Pp. 7.

Pliocene Man in America. By James C. Southall, A. M., LL. D., of Richmond, Virginia. New York: A. D. F. Randolph & Co. Pp. 30.

Braithwaite's Retrospect of Practical Medicine and Surgery. Part lxxxiii. New York: W. A. Townsend. Pp. 276.

What shall We do with the Inebriate? By T. D. Crothers, M. D. Hartford, Connecticut. Pp. 24.

Hip-Injuries, including Hip-Joint Disease, and Fractures of the Femoral Neck: Splint for. By De F. Willard, M. D. Philadelphia. Pp. 4.

Hip-Joint Disease; Death in Early Stage from Tubercular Meningitis. By De Forest Willard, M. D. Microscopic Appearances, with Cuts. By E. O Shakespeare, M. D. Cambridge: Riverside Press. Pp. 20.

Fifth Annual Report of the State Board of Health of Wisconsin. 1881. Madison, Wisconsin. Pp. 156.

Catalogue of the Phænogamous and Vascular Cryptogamous Plants of Michigan, Indigenous, Naturalized, and Adventive. By Charles

F. Wheeler and Erwin F. Smith. Hubbardstown, Michigan. Pp. 105. 50 cents.

The Mineral Resources of the Hocking Valley: Being an Account of its Coals, Iron-Ores, Blast-Furnaces, and Railroads. By T. Sterry Hunt, LL. D. Boston: S. E. Cassino. Pp. 152, with Map. 75 cents.

Educational Journalism. By C. W. Bardeen. Syracuse, New York. Pp. 30.

The Physiology of Climate, Season, and Ordinary Weather Changes. By Alexander Rattray, M. D. San Francisco, California. Pp. 20.

"The Odontographic Journal: A Quarterly devoted to Dentistry." Conducted by J. Edward Line, D. D. S. Rochester, New York: Davis & Leyden. Pp. 64. $1 a year.

Proceedings of the United States National Museum, June 2 and 22, 1881. Pp. 80.

A Manual of Accidents and Emergencies. By George G. Graff, M. D. Lewisburg, Pennsylvania: Printed for the Author. 1881. Pp. 92. 50 cents.

Revised Odd-Fellowship illustrated. By President J. Blanchard, of Wheaton College. Chicago: Ezra Cook & Co. 1881. Pp. 272. $1.

The French Revolution. By Hippolyte Adolphe Taine. Translated by John Durand. Vol. II. New York: Henry Holt & Co. 1881. Pp. 358. $2.50.

Annual Report of the Chief Signal Officer to the Secretary of War, for the Year 1879. Washington: Government Printing-Office. 1880. Pp. 782.

Algebra for Schools and Colleges. By Simon Newcomb. New York: Henry Holt & Co. 1881. Pp. 454.

The Young Folks' Astronomy. By John D. Champlin, Jr. New York: Henry Holt & Co. 1881. Pp. 236. 60 cents.

Sea-Mosses. An Introduction to the Study of Marine Algæ. By A. B. Harvey, A. M. Boston: S. E. Cassino. 1881. Pp. 281. $2.

Book of the Black Bass. By James A. Henshall, M. D. Cincinnati; Robert Clarke & Co. 1881. Pp. 470. $3.

POPULAR MISCELLANY.

Science in Politics.—"Science and Civil Liberty" was the subject of an address by Dr. W. R. Condell at a recent meeting of the Scientific Academy of Springfield, Illinois. Its object was to show the important bearing of the physical sciences on political science, and their claim to be regarded in suggesting and instituting reforms. Accepting Mr. Spencer's principle that the social aggregate must be determined by the units composing it, he derived the corollary that any social or political system, arbitrary in its nature, and not determined by the nature of the units, must be disastrous to the units or individual citizens. The scientific study of the mind from the physical side must have an important bearing upon the subject of crime as well as on other social questions which have never been solved by existing methods. The metaphysical school, whose deductions rested on a less solid basis than the hard facts of nature, had had too much influence in our legislation. Science, Dr. Condell believed, should be acknowledged as the supreme political standard; and not till this result had been consummated would perfect civil liberty be realized.

Somnambulism. — The phenomena of somnambulism arise from the fact that the faculties are unequally suspended during sleep, so that one set of organs may be active while the others are dormant. It is frequently accompanied by dreams, which arise out of a similar condition of the nervous functions. Several incidents, illustrating the manner in which the partial suspension, partial activity of the faculties affect the somnambulist, are related in an English magazine. A boy, on his way to the seaside, had traveled by steamer, railway, and coach, from six o'clock in the evening till four o'clock on the next afternoon, without cessation and with hardly any sleep. Shortly after going to bed, his companion was awakened by a crash of glass, followed by hysterical cries, and, on looking for the boy, found that he had got up, broken the window, and gone. He was found in the road, wounded in the feet. It appeared from his story that, when half asleep, he thought he saw a mad bull rushing at him. Catching hold of the curtain, which he thought was a tree, he swung himself over the hedge by which the tree grew—the window, open from the top—then jumped and ran away, breaking the window with his heel, and cutting his feet on the sharp stones. In this case the impression left on the mind of the sleep-walker was so strong as to enable him to tell all that he thought and imagined during the dream. In the next incident no trace of remembrance survived. A servant-girl came down at four o'clock in the morning, and asked her mistress for some cotton to mend her dress, which she had torn. While she was looking in her work-box some one offered her an empty spool, but she refused it, and taking up her gown pointed to two holes which she said she wanted to mend. A needle was threaded for her with black cotton, but she rejected it, saying she wanted brown cotton. Some one spoke, and she

said that it was her mistress; but it was not. Her vision was thus shown to be keen, but her hearing dull. She was wakened with considerable difficulty, and, seeing the cotton-box disturbed, asked why it had been meddled with. Several questions were asked her during the following day, to test her recollection; but she could not recall her sleep-walking, or anything that had taken place during the night. A miner near Redruth arose one night, walked to the engine-shaft of the mine, and safely descended to the depth of twenty fathoms, where he was found soon afterward sound asleep. He could not be wakened by calling to him, and had to be shaken. When awake, he could not account for the situation in which he found himself. Morrison, in his "Medicine no Mystery," tells of a clergyman who used to get up in the night, light his candle, write sermons, correct them with interlineations, and go to bed again, while he was all the time fast asleep. A similar story is told of an English dissenting preacher, who had been perplexed during the week about the treatment of the subject of his Sunday's sermon, and mentioned his perplexity to his wife on Saturday night. During the night he got up and preached a good sermon on the subject in the hearing of his wife. In the morning his wife suggested a method of treating the subject, based upon his sleep-work of the night before, with which he was much pleased; and he preached the sermon with no knowledge of its real origin. The "Lancet" has a story of a butcher's boy who went to the stable in his sleep to saddle his horse and go his rounds. Not finding the saddle in its usual place, he went to the house and asked for it, and, failing to get it, he started off without it. He was taken from the horse and carried into the house. A doctor came, and while he was present the boy, considering himself stopped at the turnpike-gate, offered sixpence for the toll, and this being given back to him he refused it, and demanded his change. A part of the change was given him, and he demanded the proper amount. When awake afterward, he had no recollection of what had passed. To prevent sleep-walking it is necessary to remove whatever is the occasion of it, if it arises from any definable disorder. Often, however, it can not be referred to any complaint; then the best that can be done will be to take precautions against the somnambulist running into any danger.

Parasites in Food and Drink. — M. Milne-Edwards has recently expressed some interesting views suggested by the discussions concerning trichina, respecting the hygienic questions which are connected with the establishment of colonies of intestinal worms, or *microbes*, within human bodies. He believes that certain religious precepts and certain established usages, among people whose civilization is very ancient, are based upon acquaintance with the inconveniences that may result from the alimentary use of particular meats or waters. He thus deduces, from the aptitude of the hog to transmit his parasites to man, the reason for the prohibition of pork among the Israelites and Mohammedans, and for the Biblical distinction between pure and impure animals. He also attributes to the very ancient recognition of analogous facts the general use of hot drinks, like tea in China and other countries of the extreme East, where the natural waters are often charged with noxious animalcules or polluted by unclean animals. As bearing on this point, he cites the ravages caused in Cochin-China by a microscopic eel, which produces a persistent endemic diarrhœa. These animals have a faculty of multiplication in the human intestine, that is illustrated by the fact that a single patient is said to have evacuated more than a hundred thousand of them within twenty-four hours! The simplest prudence should suggest the expediency of boiling the drinking-water wherever they abound.

The Great Vienna Telescope. — The equatorial telescope which has just been constructed by Mr. Grubb, of Dublin, for the observatory at Vienna, Austria, is the largest refracting telescope that has yet been made. It has an aperture of twenty-seven inches, or one inch more than that of the instrument in the Naval Observatory at Washington, and is thirty-three feet six inches long, with a tube of steel three and a half feet in diameter in the middle, and tapering to each end. The moving parts,

including the tube, polar and declination axes, counterpoise, and various adjustments, weigh altogether between six and seven tons, yet the whole apparatus is under such control that one person can move it about and manipulate it with ease. The motion on the axes has been facilitated by the application of antifriction apparatus to them, so that it has not been necessary to make them disproportionately small, as has been the case with the axes of previous large instruments. The circles are carefully and accurately divided on a band of gold, and so adjusted and illuminated that the observer can, without stirring from his chair, read all of the circles of the instrument through a single reader-telescope attached to the side of the main tube. The builder of the instrument had great difficulty in obtaining perfect glass for the objectives, and more than a year, from October, 1879, to December, 1880, was spent in trying to produce a good lens; nevertheless the instrument was completed in less than half the time stipulated for by the Austro-Hungarian Government. The observatory in which the telescope is to be placed is an imposing edifice of three hundred and forty by two hundred and forty feet, and stands at an elevation of two hundred feet above the city, upon grounds of between fifteen and sixteen acres in extent.

The Cave-Temples of India.—Dr. James Fergusson's recent work on the "Cave-Temples of India" abounds in illustrations of the manner in which the art of building in stone has been developed from wooden construction. The beginning of the use of stone in India is fixed, in Dr. Fergusson's opinion, at the period of the reign of Asoka, B. C. 250, for no stone buildings of an architectural character have been found the date of which can be proved to be earlier than that of this monarch. Moreover, all the older examples are, in all their details, so clearly copies of original types in wood, that it is improbable that they could have been executed by a people who had any previous knowledge of the principles of stone architecture. All caves, down to the seventh century, show the gradual transformation from wooden forms into those of stone. The modifications may be traced onward through nine centuries—all that was of stone being copied literally from carpentry forms, till the process was nearly complete, and forms, originally distinctly wooden, had become appropriated to stone architecture. All this seems to have been effected without any direct foreign influence. The earlier caves are adorned with sculptures in preference to painted figures, but the later ones are covered with paintings of a high order of art and great historical interest, with colors perfectly fresh, while sculpture, where it occurs at all, occupies a subordinate position. No figure of Buddha occurs before the end of the first century. The liturgical forms, in all the older caves, express a simple but exclusive type of relic-worship. About one thousand distinct caves in India are mentioned as having architectural importance, of which three fourths belong to the Buddhists, one fifth to the Brahmans, and five per cent. to the Jains. The Buddhist caves are the oldest and the most interesting. They are all true caves, excavated at right angles to the face of the rock in which they are formed, with designs appropriate to their situation in it. The caves of the Brahmans are often copies of structures whose outlines have no reference to the position in which they are placed, or the material out of which they are carved. The Buddhist caves seem to have been gradually developed from single plain cells cut into the rock, the dwelling of a single anchorite, into groups of eighteen or twenty cells, arranged around a hall sixty or seventy feet square, the roof of which was supported by pillars elaborately carved, the whole forming a *vihara* or monastery. Such caves are usually found grouped together, five or ten, and even fifty or sixty in immediate juxtaposition, so as to form an establishment capable of accommodating a large number of monks. To each of the groups was attached one or more *chaityas* or "church-caves," as they might be called, which were analogous in form and use to the choirs in Christian churches. The finest of these is that of Carlee, near Poonah.

Lunar "Craters."—M. Faye recently delivered a lecture at the Sorbonne, on the volcanoes of the moon, the substance of which was an essay to show that there are

no volcanoes in the moon. Volcanic action can only take place where water is present. The moon having no water, the idea of such action there is precluded. M. Faye supposes that the so-called "craters" of the moon were formed, not by erruptive action, but by the action of the fused mass of the interior upon the crust, after it had begun to solidify. The liquid mass was subject to tides, which, surging against the crust under the influence of the earth's attraction, washed holes in it, when the fluid rose above it, and formed ridges around the holes, in the same way as the tidal waters of the sea act upon shore-ice. The ridges thus left formed the rings or circles of the "craters." The continuing solidification of the fused matter finally caused a formation of a bottom to the crater. Sometimes the bottom, not yet firm, would yield to the pressure of the molten mass beneath it, which, rising through it again, left the central hills which are remarked in some of the circles. M. Faye does not deny that water may have once existed in the moon, and have been finally absorbed in the solid matter, but he asserts that it could never have existed in the shape of seas, or in such quantities as to occasion volcanic action. If it had so existed, evidence of its action on the land would still be visible; but no feature of the moon's surface exhibits an appearance attributable to any known action of water. The appearance of the craters is, moreover, not like that given by terrestrial volcanic action, but is that which would be given by the agency M. Faye supposes.

Arrow-Poison of the South-Sea Islands.—Herr Weisser, of the German war-ship Ariadne, has obtained from a Christianized native of the South-Sea Islands a description of the preparation of the poisoned arrows and spears of his people. It is a matter of intricate processes, and is the peculiar business of a class who possess the secret. The spear and arrow heads are made from the arm and leg bones of persons who, having died of acute diseases, have been buried for five or six months. The spear-heads are made of the larger bones of the leg, to which the shaft, inserted in the hollow, is bound with a string of bark. The other bones are sawed with an instrument made from the spines of an echinus into pieces an inch or two long, and ground down to a fine point for arrow-heads. The poison is prepared from several plants, three of which are almost invariably used. The most poisonous of them is the *toto*, a large tree, bearing handsome white flowers and a red, almond-like nut, the juice of which, sprinkled into the eyes, produces blindness, taken internally, death, and which seems to be allied to the spurges. Another plant, called *pulu*, is of the family of the dog-banes; and the third plant, called *nasola* and *fanuamamala*, is another spurge, represented in Samoa by three species. The leaves of these trees, stripped of their stems and points and dried, are pulverized; a powder of the scrapings of old weapons is added; the mass is wrapped up with a sea-worm (*holothuria*) in a leaf of *colocassia*. The foul liquid which results from the dissolution is thickened with more of the powder into a thin paste; earth gathered from the neighborhood of a wasps'-nest, and pulverized with a thigh-bone, is put in; the mixture, having been dried in the sun, is treated with the oil of an old cocoanut; a dark, cloudy oil is formed after a month of manipulation, and this is put away for a year till it becomes of the consistency of fat, when the poison is considered ready for use. The spear and arrow heads are smoked in a furnace prepared for the purpose with a particular wood. The manipulator takes a small portion of the poison, rubs it carefully upon the arrow-head, and again smokes the latter. The prepared heads are wrapped in the dried flower-stalk of a tacca-plant, and are then put in a quiver made of the cylindrical stems of the banana, and hung over the fire to dry, for dampness spoils the preparation. The poison is fatal if taken internally, but no man ever thinks of revenging himself on his enemy by administering it to him. Women, however, are said sometimes to rid themselves of an unloved husband in this way. The effect of wounds by the poisoned spears and arrows is ordinarily great local pain, followed by general disturbance of the system, ending in a few days in convulsions, lockjaw, and death. Sometimes, if the wound is cut out immediately, the patient recovers; at others, the disease assumes a more gradual form, but ends

quite as malignantly. Lockjaw appears in every fatal case. Some men pretend to be acquainted with antidotes, but their first care on being called to a patient is to remove everything that might excite him to convulsions. The father of the native who furnishes the description of the poison assured him that he had been often wounded, and had averted the evil effects by cutting himself in different parts, so as to draw away the poisoned blood.

The Secular Changes of Level in the Earth's Crust. — Professor Suesz, author of a work on the "Origin of the Alps," recently delivered an important address before the Geological Institute at Vienna, on the fundamental causes of the repeated changes which have taken place in the distribution of land and water on the globe. He assumed that, as viewed in the light of more recent observations, the question did not concern apparent elevations or depressions of land within particular spaces, but dealt with an increasing prominence of the whole northern polar cap of the earth, far down into the temperate zone, effecting a real change in the form of the planet. Howorth, who thought he had detected an elevation of the land toward both poles, and a depression near the equator, concluded that the solid part of the earth was steadily suffering a contraction in the equatorial regions, and becoming projected toward the magnetic poles. Robert Chambers, in England, forty years ago, and Domeyko, in Chili, inferred from the repeated occurrence of terraces, apparently showing that the land had risen, that a force was at work changing levels which embraced the whole planet; and, in later times, many who have studied the subject most thoroughly, as Pettersen, have not repressed their doubts of the sufficiency of the common theory of elevations to account for the phenomena which they have observed. Many have been led, from the force of these facts, to embrace the theory of Adhemars and his followers, Croll and Schmick, that accumulations of great masses of water take place alternately around one and the other pole; but the presumption of alternation is contradicted by the fact that terrace-formations occur along the coasts of South America, South Africa, and Southern Australia, which seem to be as remarkable and as regular in their distribution as those which have been observed in the northern hemisphere. In order to be accurate in expression, Professor Suesz does not speak of elevations or depressions either of the land or the sea, but of displacements of the coast-lines; of negative movements when the result is an apparent elevation, positive movements when it is an apparent depression of the land. Using these forms of expression, the height of the upper level of a series of terraces does not represent a measure of the rising of the land, but the amount by which the sum of the negative movements of the shore-line since the time when it was at its highest level is greater than the sum of the positive movements. That repeated changes from one movement to the other are the rule is shown by the step-like form of the coasts at points where many traces of them have been left, as at Van Rensselaer Harbor, Port Ffoulke, and Cape York, in the Arctic regions. Sometimes they so balance each other that the coast-line is substantially stationary for a long time, when a steep cleft in the rocks is formed, as above Montreal and at the Island of Tromsoe. We know nothing of the laws that govern these oscillations. Many of the comparisons of level hitherto made have been liable to error, arising from regarding the partly compensated sum of the several movements in one place and the latest observed movements in another place as of equivalent value. Many examples show that a positive movement has taken place on the coast of Europe within historical times, reaching at Naples to the holes in the pillars of the temple of Serapis at Puzzuoli; at a later period, perhaps between the fifth and ninth centuries, a negative movement began, of which we can not definitely say whether it still continues or not. The oscillatory character of the changes can hardly be comprehended from the point of view of a movement of the solid part of the earth's crust; it might rather be compared to the breath of a living body. Some investigators, as Charles Darwin and Kjerulf, have adopted the theory of interrupted or rhapsodical elevations, instead of the old one of symmetrical oscillations; but

the extent of the terraced shores shows that this view is erroneous. Such shores have been found everywhere in high northern latitudes, so far as their wastes have been penetrated. They are also extensively found, but generally diminishing in height, down in the temperate latitudes. In other words, around the north pole, and far down toward the south, the sum of the negative movements of the coast-lines is greater than the sum of the positive movements, but the sums become more nearly equal as we come south. The opposite is the case in the tropical waters, in the regions of the coral reefs, where the sum of the positive movements is in excess. Farther to the south, beyond the twenty-fifth to the thirty-fifth parallels of latitude, there begin again to appear, in South America, in South Africa, Southern Australia, and New Zealand, terraced lands like those of the north, the same excess of negative movements, the same signs of oscillation, as in the north. The gradual tendency to a higher exposure of the land toward both poles has been noticed in single large tracts by many observers in North America, in England, Scotland, Scandinavia, China, Australia, and South America. When we consider as a whole the character and extent of these movements, as recent observations have defined them, and regard the compensatory results of the excess of positive movements toward the equatorial regions, and of the negative movements toward the neighborhood of the poles, we shall be convinced that we should no longer speak of an inexplicable oscillation of the lithosphere. We have, in fact, to do with continuous changes in the figure of the fluid covering of the earth. Since the epoch of the maximum of cold, which Hochstetter believes came upon both hemispheres at once, an excess of positive results has taken place in the direction of the poles, causing an accumulation of water around them, and this has been followed by an accumulation in opposite directions, or toward the quator, causing a change of form which is still going on.

Persian Opium.—The production of opium has greatly increased in Persia within the last two years, and the quality of the drug has been correspondingly improved. Previous to 1876 the average annual production was about 2,000 cases, and the largest return in one year did not exceed 2,600 cases. The amount for 1878–'79 was 6,700 cases, and the estimate for 1879–'80 is for 7,100 cases. Great care is now taken to prevent adulteration, but this does not appear to be always essential. Five sixths of the product is sent to China. For this market the drug must be fine and prepared in oil, but need not be rich in morphia. It can be largely swelled up with foreign substances, with but little danger of detection by the testing processes in use there. It is said that pure and superior opium, though not so finely manipulated, has been rejected in China, while the fine opium, containing admixtures, has found favor and a fair market. The preparations intended for England are made especially pure, and yield an average of about twelve per cent. of morphia, while those intended for China yield from nine to ten per cent.

Mortality in Different Pursuits.—The reports of the British Registrars-General show that the annual death-rate in the United Kingdom is about one in forty-five of the entire population. The larger, but not the largest, towns lead in the rate of mortality, and the rural mainland districts occupy an intermediate place between them and the insular districts, the extremes varying by about fifty per cent. As between the three great classes into which the population may be divided—the laboring, the trading and professional classes, and the gentry and titled—the chances of life are very nearly equal, although a slight advantage appears to be shown in favor of the first class. The trades most unfavorable to long life are, as a rule, those which tend to expose the operative to an atmosphere loaded with dust, or compel him to deal in one way or another with poisons. Dry grinding, as practiced on needles and forks at Sheffield, is the worst; working in coal-mines is next in deadliness. Gilders and silverers of glass are exposed to vapors of mercury; workers in brass are liable to diseases produced by exposure to volatilized oxide of lead; all who work in paints are subject to great risks; soldiers and sailors have their lives shortened by the exposure they have to undergo, or by diseases

brought on by their habits of living. Bakers, tailors, and milliners are liable to consumption; compositors peculiarly so. Pressmen fare better than compositors, probably because their work is more active. In the country, farming appears to be the most healthy of occupations, while that of the innkeeper is the most fatal. Butchers die comparatively early, as also do brewers, draymen, and generally those who have much to do with establishments for eating and drinking. The over-exertion of those who follow athletic pursuits appears to conduce quite as much to short life as does the sedentary strain of the student. It seems to make but little difference in the "expectation of life" of in-door workers whether their labor is hard or not; but those who are employed out-of-doors have a chance of living six years longer, if their work keeps them busy and active, than if it is a mere matter of routine and standing around; and a "comparison of the tables leads us to the conclusion that the life of the out-door worker with little exercise is worse than that of the sedentary in-door worker, whether with little or with great exercise." The most curious fact brought out is that the scavengers, dustmen, and cleaners of sewers in London are reckoned among the healthiest of the population.

Conditions of Color in Flowers.—The physiological processes of the coloring of flowers and the relations of different agencies, as light, temperature, the nature of the soil, and natural selection, are examined by F. Hildebrand in a work on the present variations and former development of the colors of flowers. The variations in the colors of flowers seem to be without limit, yet they are controlled by laws both in nature and in cultivation. Each kind has certain directions in which variations are more likely to take place, which are limited in extent, and are denoted by the colors which its congeners prefer. The character of the variations which any one species will take corresponds with the variation direction of other species of the genus, and can not be essentially changed by cultivation. All colors may be made to turn to white. Blue-blooming species may be made to vary to violet and red, but not, with the single exception of the blue hyacinth, to yellow. The variations of red-blooming species incline toward the colors of the nearest related species; if both yellow and blue kinds occur among the latter, the inclination is rather to the yellow tints, but a pure blue is never reached. Efforts have been made without success to produce blue pinks, zinnias, roses, hollyhocks, ranunculuses, primroses, and balsams. A yellow-blooming species will not vary to clear blue, even when there is a blue species in the same genus. Generally, the yellow-varying species belong to such genera as move in the red and yellow circle of colors, and the variations occur inside of this circle. The membrane of the plant-cells is nearly colorless. Colors arise either from the chlorophyl, the coloring-matter connected with the solid bodies within the cells, or through the coloring of the cell-juices, or by changes taking place in both the chlorophyl and the cell-juices. The red and orange colors are generally derived from the chlorophyl, as is exemplified by the fact that the red and orange masses in many flowers are frequently developed out of masses that were before green. The chorophyl is seldom replaced by a red or blue grainy matter. White is readily produced, for all that it requires is the absence of chlorophyl or its presence in only a limited quantity. Other colors are produced by the coloring of the cell-juices with other matter than chlorophyl. So originate the rose-red flowers, some of the fiery red, most of the violet and blue. If no coloring takes place, the flower is white; hence the abundance of white flowers, and their occurrence whenever a species is made to vary. If a change takes place in both parts, if the chlorophyl is modified and the cell-juice is colored too, mixed colors, both bright and dark or dusky ones, are produced. A bright red often becomes prominent in this way, which, when combined with yellow arising from the chlorophyl, gives such colors as we find in the canna and nasturtium. Dark colors are produced by the association of green or yellow grains of chlorophyl with a violet juice, as in the nightshade. We look for the origin of diversities of color to conditions of light, temperature, and soil, and to the operation of natural selection. Dif-

ferent plants require different degrees of light and heat for the formation of their colors. Ferns and conifers need but little. Different colors require different degrees for their development; yellow is an exception, for it seems to be found equally well under the most varied circumstances. Some red flowers, as the tulips, color well in the dark, and the blues and violets seem partly independent partly dependent on the light. The crocus takes on its deep-blue violet in the dark, while the *Prunella grandiflora* remains white. A steady supply of nutriment is essential. Askenasy tried some cut branches of foxglove and other plants in a glass exposed to a strong light. The first flowers that came out were bright, but the others grew paler, and the last were nearly white. The failure of nourishment neutralized the stimulating effect of a strong light. The effect of these external agencies is dependent on the disposition of the flower to particular colors. They may aid the tendency, but do not perceptibly modify it. The supposition that particular seasons are favorable to the development of particular colors is not fully established; and the real amount and extent of the influence of changes of season on color is not ascertained. The investigation of the effect of the soil is attended with great difficulties. When we change the soil, we change other relations, as those of light and temperature, without being able to measure the part that each may have in producing the result we see. By introducing changes in all the conditions we cause an abrupt modification in the life of the plant, by which it becomes more docile to our treatment. Hence most of the variations take place under cultivation. Variation once started, further changes are comparatively easy. Natural selection operates to perpetuate variations. Those colors which stand out most distinct from the surrounding green attract the insects which act as fertilizing agents, and become predominant and permanent.

A Fortress of the Polished-Stone Age in Spain.—M. A. F. Nogués, mining engineer, gives in "La Nature" an account of a fortified camp of the polished-stone age, situated on the plateau of Maestrazgo, Spain, which was discovered by the Abbé Ambrosio Sans, and which he has recently visited. The work is situated on the elevation called the Muela de Chert, which constitutes the highest groups of hills of the plateau, rising 2,880 feet above the sea. The end of the plateau shows a steep limestone ledge inaccessible at almost every point. At a considerable distance from this point, the lines of the fort are marked by an irregularly disposed mass of weather-browned stones running across the ridge which is the continuation of the Muela, and separating the higher parts of the eminence from the lower levels of the plateau. A real fortified inclosure is thus formed, defended on one side by the natural precipitous escarpment, and by the wall along the rest of the circuit. The curved part of the wall, for a length of about eight hundred feet, is built of stones without mortar, arranged from the level, not of the surface of the ground, but of excavations made in the mountain by the prehistoric builders. On the south, the wall ends at a short distance before reaching the precipice; and here are found traces of an opening or the gate to the inclosure, which is about eight feet wide at the bottom. In the interior of the fortification are a smaller wall, still intact, and piles of stones, the remains of former habitations, the greater part of which have, however, disappeared. Those which have been traced were of an oval form, about twenty feet long by six and a half feet wide, sometimes grouped, sometimes isolated, but arranged apparently so as to conform to some politic regulation. When the ruins were first discovered, the bones of many animals which are now extinct in Spain, as well as those of some still living in the country, were found at the bottom of the wall. Without the inclosure were found stone implements, polished hatchets of a white, reddish-veined quartz, lance-points of blackish diorite, and other objects of the polished-stone age. Such a work could only have been constructed by a settled population, who had already attained considerable numbers. No traditions of the historic period mention such fortifications; and on this fact, as well as on the occurrence of the remains of animals that have not lived in Spain for time immemorial, is based the presumption that the structure dates from

an extreme antiquity. This is one of the most important works of this kind that have attracted the attention of European archæologists.

NOTES.

Professor O. N. Rood, of Columbia College, describes, in a late number of the "American Journal of Science," a modification of the Sprengel pump, by which he has been able to obtain a vacuum of $\frac{1}{3000000000}$ "without finding that the limit of its action had been reached."

Alden B. Hurt, not Huet, as it was wrongly printed, is the name of the author of the article "Union of the Telegraph and Postal Service" published in the July "Monthly."

The center of population of the United States appears now to have reached a point in latitude 39° 03′, about five miles west of Covington, Kentucky, ten miles east of the boundary-line between Indiana and Ohio, and fifty-one miles west and a few miles south of the point it reached in 1870. It has moved westward about four hundred and fifty miles since 1790.

Mr. John Fergus McLennan, an industrious student in anthropology, died in June of lung disease, from which he had suffered for many years, aggravated by a fever caught in Algeria. His investigations were directed chiefly to the history of institutions. Their results were given principally in his essays on "Plant and Animal Worship," in the "Fortnightly Review," which first drew attention to the distribution and historical importance of totemism, and in his essays on "Primitive Marriage."

A French scientific journal relates an incident illustrating the susceptibility of spiders to music. A party at a country-house had formed a quartet and were performing a number of pieces, when two spiders were observed to descend upon their threads and hang near the top of the window of the room. They continued there for an hour, and did not go back to their nests till the music had stopped.

Dr. Beddoe and Mr. Tuckett have stated that "British heads are smaller than British heads used to be," and Mr. Horsfall, in the "Manchester Guardian," infers from this and other facts that the English people are physically deteriorating. The conditions under which youth are brought up in these days, without access to play-grounds and public gymnasia, with smoking and drinking as their principal recreations, are such as to favor the stunting of the race. The "Lancet" takes up the thought, and points to the mode of life of a large number of urban people as the great evil of civilization. It urges the multiplication of places for open-air recreation and gymnasia, with increased freedom of admission to them.

The ninth award of the Rumford medal has been made by the American Academy of Arts and Sciences to Professor J. Willard Gibbs, for his researches on thermo-dynamics, and the medal was formally conferred upon that gentleman in January last. Professor Gibbs, in entering upon his investigation on the "Equilibrium of Heterogeneous Substances," the work for which the medal was conferred, took his departure from the two propositions enunciated by Clausius, that "the energy of the world is constant," and "the entropy of the world" (that is, the energy not available for work) "tends constantly toward a maximum," and held as his leading object to develop the parts of energy and entropy in the theory of thermo-dynamic equilibrium. His researches were declared by the President of the Academy to be "the consummate flower and fruit of seeds planted by Rumford himself, though in an unpromising soil, almost a century ago," when he showed how water could be boiled by the heat developed in boring a cannon.

Sir Josiah Mason, founder of the Mason Science College, died at Birmingham, England, in June, at the age of eighty-six years. He rose from the humblest ranks, having begun life as a street hawker and Jack-at-all-trades. He became employed in the gilt toy trade in 1814, and engaged in the manufacture of split rings in 1822. He afterward added the manufacture of steel pens, and became the greatest producer of them. He established an orphanage at Edlington in 1860, expending £300,000 upon it, and received the honor of knighthood in acknowledgment of his work. He afterward built up and endowed the Mason Science College, the inaugural address of which was delivered by Professor Huxley, giving it a total sum of about a quarter of a million pounds sterling.

M. de Bisschop has won a prize of one thousand francs, or two hundred dollars, for a small motor suited to use in families. His engine is worked by gas, and the operation costs, at the prices current in Paris, two cents an hour for machines doing a work of 36·17 foot-pounds per second, five cents an hour for machines performing at the rate of 180·8 foot-pounds per second. The smaller machines are sold for one hundred dollars; the larger ones for one hundred and eighty dollars.

THE French Minister of Public Instruction is organizing at the Trocadéro a museum of ethnography, to contain the collections of the exploring parties by which France is represented, in nearly every quarter of the world, which will be under the charge of M. Armand Landrin and M. Hamy. The American department is nearly ready to be opened. It is arranged in geographical order, beginning with Alaska, Labrador, and Canada, and ending with Brazil. The departments of the states farther south must for the present remain empty for the want of specimens. California is represented by a tomb made of sand, shells, and kitchen-midden stuff, containing the bones of the deceased, by collections of cut flints, dolls, toys, and idols; Mexico by mummies—some of which are very well preserved, while others are but skin and bones—mirrors of polished pyrites, and all kinds of divinities.

HERR HOLTZ has concluded, from the comparison of the statistics of thunderstorms and the damage occasioned by them in Germany, Austria, and Switzerland, from 1854 to 1870, that, while the increase in thunderstorms has been small, the risk from lightning has been very largely augmented. He believes the change to be partly due to the destruction of forests, the extension of railways, and the use of iron in house-building.

PROFESSOR GEORGE ROLLESTON, Linacre Professor of Anatomy and Physiology in the University of Oxford, died in June, at his home in Oxford, in his fifty-second year. His life was one of scientific activity. He began his career, after being admitted to practice as a physician, as assistant surgeon in the British Civil Hospital at Smyrna during the Crimean War. He became Lee's Reader in Anatomy at Christ Church College, Oxford, in 1857, and was appointed to his professorship, as the first to occupy the newly founded chair, in 1860. He is best known by his work on "The Forms of Animal Life," an outline of zoölogical classification based upon anatomical investigations, by his important contributions to Canon Greenwell's "British Barrows," and by numerous contributions to the "Transactions" of the Royal Linnæan and Archæological Societies, and to many scientific journals.

PROFESSOR IRA REMSEN has recently reported to the National Board of Health the result of investigations he has made to ascertain whether carbonic oxide escapes from cast-iron stoves and furnaces in sufficient quantities to be dangerous. French chemists have asserted that it does; experiments made in Germany have failed to sustain their conclusion. Professor Remsen used Vogel's test for carbonic oxide, as improved by Hempel, and was able to detect as small a quantity as 0·04 parts of the oxide to 1,000 of air, while Vogel by his original test could not detect a smaller proportion than 2·5 parts per 1,000. In a careful examination of several furnaces in Baltimore, including some bad ones, carbonic oxide was not detected in a single case. A stove of peculiar construction was experimented upon under various conditions, to ascertain whether carbonic oxide actually passes through cast-iron heated to redness, with the result that none of the gas was found escaping. The conclusion is therefore drawn that if carbonic oxide is present in rooms it is in a smaller proportion than 0·04 parts per 1,000; and it remains to be shown whether so small a quantity is dangerous to health.

AMONG the recent entomological contributions to the "American Naturalist" is one by George Marx, of Washington, D. C., on a tube-constructing spider which he has discovered in the grounds of grass lands. The nests of these insects are outwardly about three quarters of an inch high, composed of grass, sticks of wood, etc., and much resembling a bird's nest. Within they are cylindrical, and communicate with a shaft some eight or nine inches deep, at the bottom of which was found (in October) a torpid spider. The nest and tube were strengthened by a lining resembling a very fine tissue-paper, which showed under the microscope no web-structure, but a hardened tissue, like varnish. Several of the nests were found, all constructed on the same plan. Nests of a similar character, but not identical, are described by Mr. Nicholas Pike, Mr. S. H. Scudder, and Mrs. M. Treat, as having been found in the sand near the seashore. Mr. Marx believes his specimens to be of a different species from the others, chiefly because the nests of the latter appeared to be used in summer and to contain eggs, while his nests were fresh in the fall, dilapidated and empty in the summer, indicating that they were used only as winter residences.

PROFESSOR J. W. MALLET has published an account of his determinations of the atomic weight of aluminum by series of experiments in three methods. The first method was by the ignition of ammonia alum, the second by the precipitation of the bromine in aluminum bromide by silver, and the third by the evolution of hydrogen through the action of metallic aluminum upon sodium hydrate. In the last method the hydrogen was determined, first, by the direct measurement of its volume, and, second, by weighing the water produced by its oxidation. The mean result of thirty experiments, ten in the first method, eleven in the second, and nine in the third, rejecting one of the results as too wide of the mark, was 27·02.

CHARLES A. YOUNG.